Report No. 1495-KO

Korea: Appraisal of the Heavy Machinery Project

(In Two Volumes)

Volume II: Annexes

May 31, 1977

Industrial Projects Department

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CURRENCY EQUIVALENTS

Except where otherwise noted all figures are quoted in Korean Won (Won)

US$ 1	=	Won 485
Won 1	=	US$ 0.00206

WEIGHTS AND MEASURES

All weights and measures are in metric units.

1 metric ton (ton)	=	1,000 kilograms (kg)
1 metric ton (ton)	=	2,205 pounds (lb)
1 kilometer (km)	=	0.621 miles
1 meter (m)	=	39.37 inches
1 cubic meter (m^3)	=	35.31 cubic feet (cu ft)

PRINCIPAL ABBREVIATIONS AND ACRONYMS USED

ADB	-	Asian Development Bank
EPB	-	Economic Planning Board
GE	-	General Electric of the U.S.
HCC	-	Hyundai Construction Co., Ltd.
HII, the Company	-	Hyundai International Inc.
IMC	-	Ingersoll Manufacturing Consultants of the U.S.
KDI	-	Korea Development Institute
KECO	-	Korea Electric Company
KIST	-	Korean Institute of Science and Technology
MW	-	Megawatt
POSCO	-	Pohang Iron and Steel Company
TPY	-	Tons per year (metric)

HII FISCAL YEAR

January 1 - December 31

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HEAVY MACHINERY PROJECT

ANNEXES

ANNEX 1

KOREA

HEAVY MACHINERY PROJECT

PROJECT EVOLUTION

Event	Timing	Remarks
Evolution		
Loan Application submitted by EPB	April 1976	Accompanied by preliminary Project Study
Visit to the Bank by HII	June 1976	Preliminary Discussions
Reconnaissance Mission in Korea	July 1976	Requested Feasibility Study
Appointment of consultants by HII	Sept. 1976	Appointed IMC
Submission of Feasibility Report	Nov. 1976	Jointly prepared by HII and IMC
Appraisal Mission in Korea	Nov.-Dec. 1976	
White Cover Appraisal Report	Feb. 1977	
Distribution of Yellow Cover Appraisal Report	March 1977	
Mission to update information	March 1977	
Distribution of documents to Loan Committee	April 1977	
Invitation to negotiate and negotiation	May 1977	
Final agreement on documents by Government	May 1977	
Consideration by Executive Directors	June 1977	

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HYUNDAI GROUP

A. Introduction

1. The Hyundai Group is made up of eight affiliated companies which are loosely held together by the fact that controlling interest in each is vested with the Chung family. The Group's origin can be traced back to the Hyundai Construction Company which was founded in 1945 by Mr. Ju Yung Chung, eldest of the four Chung brothers, all of whom are actively involved in running the family's business. The Construction Company subsequently branched into various other operations, directly or indirectly related to construction. Several of these were later reorganized into independent operating companies, while other companies were formed as the Group diversified its operations. A description of each of the companies in the Group, all with headquarters in Korea, is provided in the following paragraphs. Summary financial data for Group companies and details on their ownership structure are provided in Tables 1 and 2 at the end of this annex.

B. Hyundai Construction Co., Ltd

2. Hyundai Construction commenced operations in 1945 and was incorporated in 1950. It is presently the largest construction company in Korea with extensive activities in both domestic and overseas markets. Present facilities include: 8,000 units of heavy construction equipment, a heavy equipment maintenance shop, rock crusher and asphalt plant, and a concrete block plant. The company has a reputation for low cost, high quality, and efficient execution of construction projects. In Korea these have included: highways, bridges, dams, power plants, industrial plants (including steel and petrochemical plants), housing complexes and hotels. Abroad, Hyundai Construction has built highways in Thailand and Indonesia, bridges in the U.S., power plants in Papua, New Guinea and harbor facilities in Australia. The company also has significant and expanding operations in the Middle East where it is engaged in the construction of major shipyards in Bahrain and Iran and port facilities in Saudi Arabia.

3. As of year-end 1976, the company held assets of US$406 million, and earned before taxes US$30.6 million on sales of US$278 million.

C. Hyundai International Inc.

4. This company, the sponsor of the proposed project, was incorporated in 1962 to conduct international trading operations for the Hyundai Group. While this activity ceased in 1973, its operations now include the manufacture of heavy construction equipment, auto parts, and iron and steel castings and forgings, as well as the operation of four ocean-going freighters for world-wide tramping services.

5. Hyundai International employs some 3,500 staff, and in 1976 earned US$1.5 million on sales of US$47 million, and assets of US$92 million. Details on the company's operations are given in Annex 2-4 and 2-5 and in the main text of this report.

D. Hyundai Shipbuilding and Heavy Industries Co., Ltd.

6. Hyundai Shipbuilding was formed for the purpose of building a variety of cargo vessels and supertankers. Construction of the shipyard, financed by a US$70 million loan from a European consortium and guaranteed by the Government of Korea, began in March 1972. By November 1974, the shipyard had delivered its first two tankers of 259,000 DWT each. The shipyard consists of three large dry docks, hull shop, steel fabrication shop, assembly shop, paint shop and out-fitting shop. Altogether, the facility is capble of producing ten 300,000 DWT vessels every year.

7. The company employs a total of over 18,000 people, and in 1976 incurred losses of US$27 million (against 1975 profits of US$21 millon) on sales of US$380 million and assets of US$397 million.

E. Hyundai Motor Company

8. The Hyundai Motor Company was incorporated in 1967 to assemble passenger cars, buses and trucks under license from the Ford Motor Company of the U.S. In 1975, the company completed construction of an integrated automobile plant with an annual capacity of 80,000 units of cars and commercial vehicles (including the popular Hyundai Pony - the first original Korean car). The new plant includes an engine assembly shop, foundry and forge, die and tooling shop, stamping plant, parts manufacturing plant, and an assembly plant. As a result, the company has increased the local content of its products to about 65% of total value. Overall, Hyundai Motor is the largest auto manufacturer in Korea with about 55% of the local passenger car and bus markets.

9. In 1974, the company went public, with an issue of just under 50% of its capital stock to the general public. The company employs about 1,600 people, and in 1976 earned US$7.3 million before taxes on sales of US$109 million and assets of US$159 million.

F. Hyundai Cement Co., Ltd.

10. This company developed from a division of the Hyundai Construction Company which established a 400,000 metric ton portland cement plant in 1964, with USAID financial assistance. In 1970, the Hyundai Cement Company was incorporated to take over the operations of the plant with a view to improving its manufacturing and sales efficiency. In 1974, the company completed an expansion project, raising plant capacity to 1.2 million metric tons per annum. The expansion was financed by the US Exim Bank and a US commercial bank.

11. Hyundai Cement became a publicly-owned corporation in 1975. As of year-end 1976, the company's total assets amounted to US$37 million, with sales of US$30 million on which it earned profits of US$0.5 million.

G. Keum Kang Asbestos Cement Industries Co., Ltd.

12. This company was established in 1958 to manufacture various types of construction materials for the domestic and foreign markets. Major products include corrugated and ribbed asbestos/cement sheets, and interior walls and partitions for office and institutional use.

13. Keum Kang went public in 1973, the first of the Group companies to do so. Total earnings in 1976 amounted to US$0.7 million on sales of US$30 million and assets of US$21 million.

H. Hyundai America Corporation

14. Hyundai America was established as an integrated construction contractor in the U.S. territory of Guam, in 1968. Since then, the company has successfully built a number of public and private projects including: schools, generating plants, offices, condominiums and housing units. The company held assets of US$15 million and reported a loss of US$1.5 million on sales of US$5 million in 1976.

I. Hyundai Mipo Dockyard Co., Ltd.

15. This company was established as a joint venture between Hyundai Shipbuilding and Heavy Industry Co., Ltd. and Kawasaki Heavy Industries of Japan in 1975. Facilities include repair docks and a quay with the capacity for repairing 200 large scale ships per year, up to an individual size of 700,000 DWT. The company is based alongside the Hyundai Shipyard in Ulsan and employs 2,500 persons. In 1976, the company held assets of US$21 million and incurred losses of US$0.1 million on sales of US$11 million.

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HYUNDAI GROUP FINANCIAL DATA

(Won Millions)

	Year Ending December 31	Total Assets	Long Term Debt	Net Worth	Net Sales	Pre-Tax Profit	Return on Sales (%)	Return on Net Worth (%)	Current Ratio	Debt/ Equity Ratio	Number of Employees
Hyundai International Inc.	1975	21,706	5,147	6,407	11,512	340	3.0	5.3	0.8	45:55	2,400
	1976	44,520	18,297	6,767	23,062	744	3.2	11.0	1.0	73:27	3,500
Hyundai Construction Co., Ltd.	1975	46,144	2,477	15,189	54,540	6,585	12.1	43.3	1.0	14:86	2,400
	1976	196,704	2,170	32,029	135,048	14,825	11.0	46.3	0.9	6:94	n.a.
Hyundai Shipbuilding and Heavy Industries Co., Ltd.	1975	195,996	62,859	17,034	113,063	10,175	9.0	59.7	1.3	79:21	18,000
	1976	192,558	66,154	3,216	184,152	(13,172)	(7.1)	-	1.3	95:5	n.a.
Hyundai Motor Company 1/	1975	60,875	30,500	10,810	30,377	2,545	8.4	23.5	1.3	74:26	1,600
	1976	77,305	37,276	15,217	52,789	3,558	6.7	23.4	1.5	71:29	n.a.
Hyundai Cement Co., Ltd. 1/	1975	17,751	8,428	3,575	14,425	261	1.8	7.3	1.1	70:30	650
	1976	15,796	7,867	3,924	15,946	543	3.4	13.8	1.5	67:33	n.a.
Keum Kang Asbestos Cement Industrial Co., Ltd. 1/	1975	8,475	1,529	1,775	10,650	268	2.5	15.0	1.1	46:54	1,100
	1976	10,124	1,335	3,024	14,548	377	2.6	12.5	1.2	31:69	n.a.
Hyundai America Corporation	1976	7,130	905	475	2,271	(722)	(31.8)	-	1.2	66:34	n.a.
Hyundai Mipo Dockyard Co., Ltd.	1976	10,603	6,427	1,860	5,422	(62)	(1.1)	-	1.2	78:22	n.a.
Total Group 2/	1975	350,947	110,940	54,790	234,567	20,174	8.6	36.0	n.a.	67:33	29,920
	1976	554,740	140,431	66,512	433,238	6,091	1.4	9.2	n.a.	68:32	n.a.

1/ Publicly owned companies

2/ Total group figures are for information purposes only. They do not represent a consolidation since intercompany transactions have not been eliminated in the totals.

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ANNEX 2-1
Table 1

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HEAVY MACHINERY PROJECT

HYUNDAI GROUP OWNERSHIP STRUCTURE

	No. of Shares (000's)	%
Hyundai International Inc.		
Chung, In Yung	305.3	50.9
Hyundai Construction Co., Ltd.	265.5	44.3
Other Chung Family Members	29.2	3.3
Other Shareholders	9.0	1.5
	600.0	100.0
Hyundai Construction Co., Ltd.		
Chung, Ju Yung	306.8	59.0
Chung, In Yung	130.0	25.0
Other Shareholders	83.2	16.0
	520.0	100.0
Hyundai Shipbuilding and Heavy Industries Co., Ltd.		
Hyundai Construction Co., Ltd.	3,530.0	88.3
Chung Family Members	450.0	11.2
Other Shareholders	20.0	0.5
	4,000.0	100.0
Hyundai Motor Company 1/		
Hyundai Construction Co., Ltd.	3,667.2	30.6
Chung, Se Yung	1,024.1	8.5
Other Chung Family Members	295.7	2.5
Other Shareholders	7,013.0	58.4
	12,000.0	100.0
Hyundai Cement Co., Ltd. 1/		
Hyundai Construction Co., Ltd.	1,194.1	39.8
Chung Family Members	290.0	9.7
Other Shareholders	1,515.9	50.5
	3,000.0	100.0
Keum Kang Asbestos Cement Industrial Co., Ltd. 1/		
Chung, Sang Yung	243.8	22.4
Other Shareholders	844.5	77.6
	1,088.3	100.0

1/ Publicly owned companies

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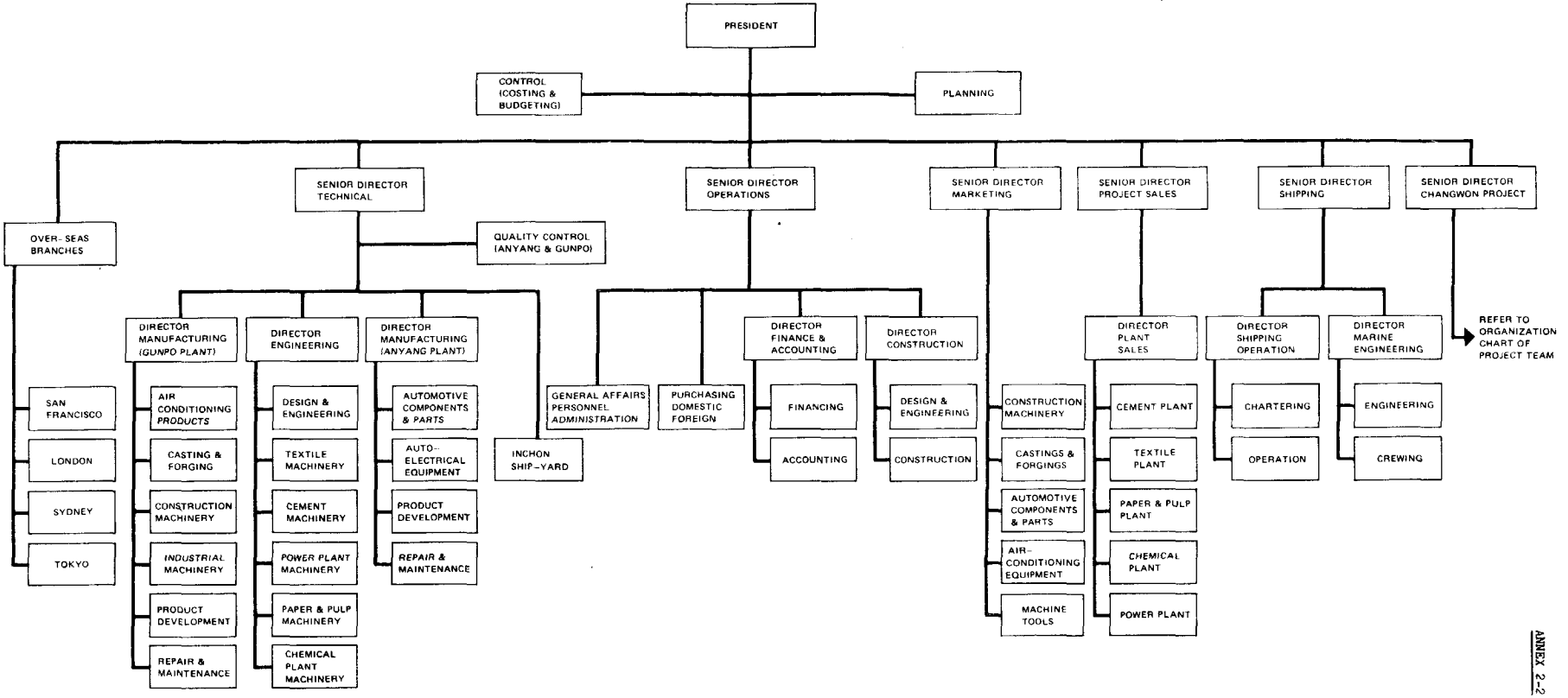
Existing Organizational Structure of Hyundai International



ANNEX 2-2

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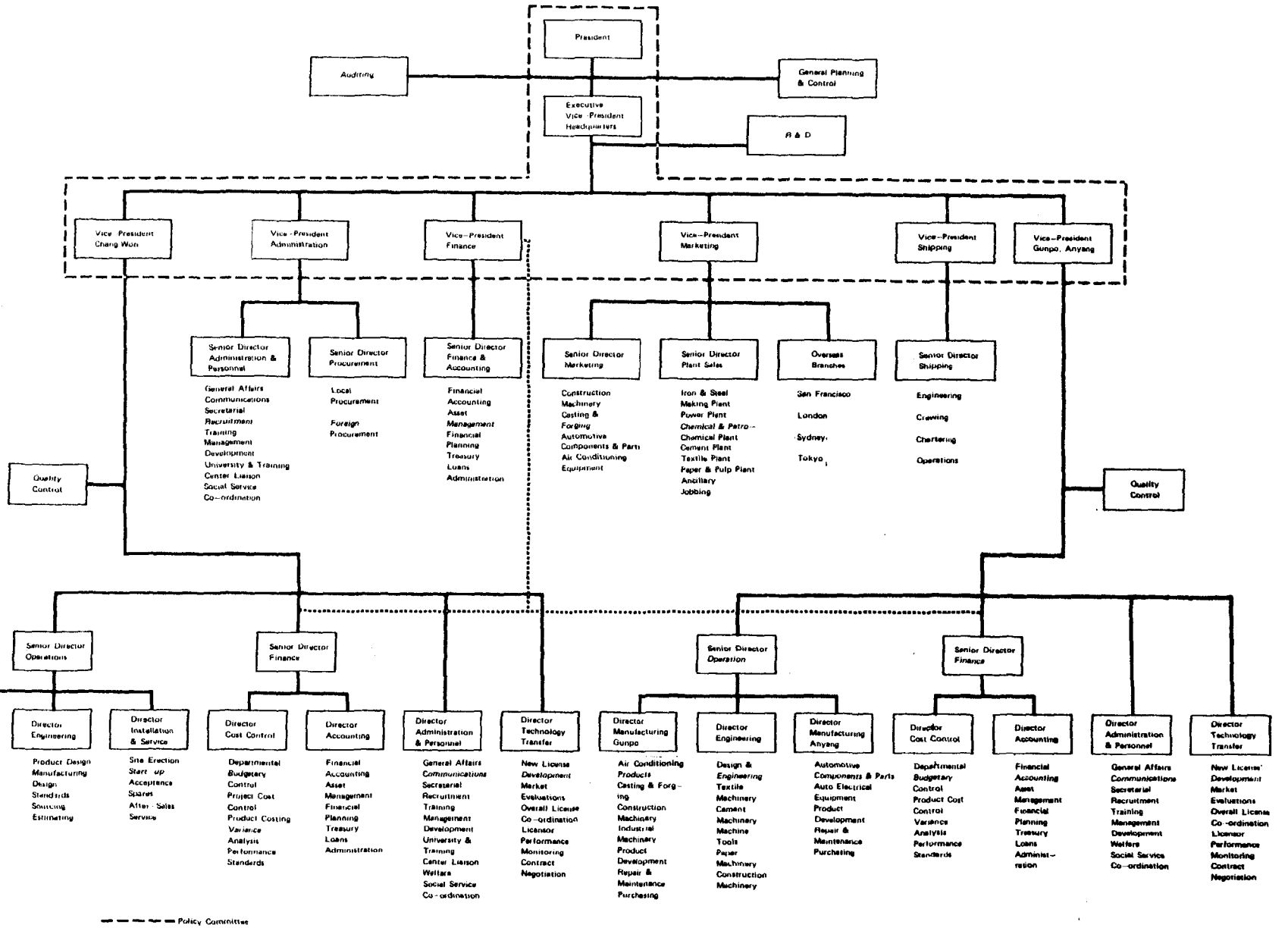
KOREA HEAVY MACHINERY PROJECT

PROPOSED GENERAL ORGANIZATION AFTER PROJECT COMPLETION



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HEAVY MACHINERY PROJECT

EXISTING FACILITIES OF HII

A. Background and Development

1. HII was established in 1962 as a joint stock company under the Commercial Code of the Republic of Korea, to carry out trading activities for the Hyundai Group. It first concentrated on exporting products of the Hyundai Group and importing industrial and construction materials and equipment. HII entered the field of manufacturing in 1965 by establishing a machine shop at Anyang (26 km. from Seoul), for producing stainless steel tableware. Further, in 1968 the Company supplemented its trading operation by international shipping operations on a small-scale. In 1969, the table-wares plant was expanded and modified for the production of various automobile parts such as shock absorbers, engine radiators and side-frames. The Company expanded its manufacturing operations in 1970 when it initiated the construction of a machinery manufacturing plant at Gunpo (30 km. from Seoul) by setting up a foundry for the production of iron and steel castings. This was followed by the additin of a machine-shop in 1972 and a forging facility in 1973 and subsequently HII began to manufacture heavy construction machinery. The shipping operation was strengthened and by 1973, HII was operating four ocean-going vessels with a total tonnage of 70,000 DWT. As other operations gained in importance, the trading activity was curtailed and discontinued in 1973. The Company added a range of electrical auto-parts to its Anyang product-line through further expansion in 1974.

2. In mid-1975, the Company received a US$17.5 million loan from the Asian Development Bank (ADB) for expanding the Gunpo facility into an integrated machinery manufacturing plant at an estimated total cost of US$30 million. The Company is in the process of completing the expansion, which would place HII in a position to manufacture a variety of heavy construction equipment; water chillers; machine-tools; textile-spinning, cement and paper machinery; and a range of forgings, castings and fabricated products. Recently, the Company negotiated another loan for US$7.6 million from the U.S. Exim Bank for a further increase in the capacity of the Gunpo plant.

3. The Gunpo facility contributed 54% of HII revenue in 1976, Anyang 31% and shipping 15%. With the completion of the current expansion, Gunpo would become significantly more important than HII's other existing operations. By 1979, when Gunpo is expected to reach full operational status, it alone is projected to generate around US$200 million in annual sales revenues, as compared to about US$48 million of HII's entire turn-over at present.

B. Present Facilities

1. The Gunpo Plant

4. The Gunpo facility, begun in 1970 with a Foundry shop, has since been expanded into a large facility with the flexibility of manufacturing a diverse range of light and medium machinery and related products. For current products, manufactured under international licenses, see Annex 2-5. Upon completion of the current ADB-financed expansion, scheduled for early 1977, the plant will comprise 99,000 m^2 of building area spread over a site covering 264,000 m^2. The space-allocation to the primary facilities and their estimated capacities are summarized in Table 1.

5. The Foundry and Forge shops: The melting shop comprises a 1-ton induction furnace, a 3.5 ton cupola and a 10-ton arc furnace all of which are already in place. Another 10-ton arc furnace has been provided for in the current expansion plans. The shop incorporates modern sand preparation, sand slinging and sand conveying and return systems for use in conjunction with the automatic and manual moulding lines. The casting operation is supported by suitable pattern-making equipment, shot-blasting machines and annealing and hardening furnaces of various sizes. The estimated annual capacity of the shop is about 15,000 tons of steel castings and 6,000 tons of iron castings. The forge shop, located adjacent to the foundry, is equipped with a 2 ton free-forging press capable of handling ingots up to 5 tons in weight. For small forgings, the plant utilizes three air-operated drop hammers with a maximum weight capability of 15 kg, 30 kg and 50 kg, and suitable upsetting and trimming presses.

6. A large heat-treatment facility is housed separately and includes a broad range of heat-treating and hardening furnaces. It also includes specialized induction-hardeners for components of heavy construction equipment such as bulldozer track links and a rotating hardener for sprockets, wheels and gears.

7. The Heavy Machinery and Fabrication Shop: The machining capability at Gunpo is divided into two areas: light machining and heavy machining. The heavy machine shop is housed in a 32,000 m^2 structure along with the fabrication shop, 2 bays being used for machining and 3 bays being used for fabrication and assembly. The heavy machinery is being provided under the ADB and U.S. Exim Bank loans and includes a large number of lathes, verticle and horizontal boring mills, planers and plano-millers, drilling and grinding machines, gear-making machinery, a dynamic balancing machine and numerically controlled machining centers. The heavy machining capacity of the shop is estimated at over 182,400 machine-hours, assuming 3-shift operation.

8. The fabrication shop provides significant capability with a 800 ton dishing press, a 600 ton press brake, two sets of plate-bending rolls and a range of other presses, shears, angle-bending tube-bending and turning rolls. The shop also provides six sets of gas-cutting equipment including

a plasma-arc cutting machine. In the welding area sixteen sets of different types of welding machines are available and include MIG and TIG arc welders and self-propelled submerged-arc welding machinery.

9. The Light Machine Shop: The light machine shop is housed in a 14 bay, 27,000 m^2 structure. Eight bays within the shop are utilized for crane and under-carriage assembly and a repair and maintenance facility. At the machine-end, the heavy machinery is adequately supplemented at the light-end through the provision of a number of lathes (84), milling and drilling machines, shapers and slotters and grinding machines. Within the light machine-shop there is a provision for a tool-room and other support areas. The capacity of the light machine shop is estimated at over 1,186,000 machine hours on the basis of 3-shift operation.

10. Manpower Resources: The Gunpo plant employed at year-end 1976 a total labor force of around 700. Of these, 650 are employed in administrative and engineering functions. In order to manage the technology transfer under the range of existing foreign licenses (see Annex 2-5), the Company is in the process of strengthening in-house engineering capability. Gunpo currently employs around 170 manufacturing engineers and an additional 200 people working in design, drafting and related functions. By 1979, when Gunpo is expected to attain full capacity, the engineering and labor resource is expected to double.

11. Gunpo project-completion experience: The ADB financed expansion project was estimated to be completed in August 1977. In view of progress to-date, the project-implementation is proceeding three months ahead of schedule and is expected to be completed in June. The project cost experience is shown below. The increase is almost entirely related to a change in project scope, to accomodate additional machinery financed by the U.S. Exim Bank.

HII: ADB Financed Expansion Project Experience
(US$000)

	Initial Estimate (Appraisal March '75)			Current Estimate (December '76)		
	Local	FX	Total	Local	FX	Total
Building Works	1,600	-	1,600	5,391	-	5,391
Machinery: Under ADB Loan	-	14,100	14,100	-	16,813	16,813
Local Funds	390	-	390	1,028	-	1,028
Utility & Auxiliary Equipment	1,040	-	1,040	4,080	181	4,261
Others	548	400	948	548	-	548
Contingencies	827	3,000	3,827	-	-	-
Total	4,405	17,500	21,905	11,047	16,995	28,042

The unit cost experience at Gunpo adjusted for inflation has been used as the basis for estimating construction costs for the Heavy Machinery Project.

12. The Gunpo facility with its significant light and medium engineering capability will be of considerable assistance to the Project in both the construction and operational phases. It has already served a useful function in providing qualified and experienced manpower for the early design and planning stages of the project. It will provide a great deal of assistance in the early Project fabrication work, through the availability of its facilities and trained labour. In the early operational phase it will supplement training facilities included in the Project and serve as a productive training ground itself. Finally, in the operational phase, it will complement the Project's heavy engineering capability by providing medium-sized forgings and castings and machined components. The Project design takes these factors into account in establishing equipment requirements.

2. The Anyang Plant

13. The Anyang plant was HII's first venture into manufacturing activity beginning with the production of stainless steel wares and expanded to manufacture a line of automotive components under different international licenses (see Annex 2-5). In relation to Gunpo, it is a small facility, catering to mass-production of light automotive products.

14. The Facilities: The plant is structured along product-lines in accordance with its mass-production orientation, with some common facilities such as the press-working and painting shops, a die-making shop and a laboratory. The product-oriented lines are: the brake and steering system line, the shock-absorber line, the radiator shop and lines for different automotive electrical equipment such as starter motors and ignition coils. Six heat-treating furnaces are provided in the plant to meet annealing, tempering and hardening requirements. A continuous sinter furnace was installed recently to extend the Company's capability into the production of sintered metal products. The primary production facilities are housed under two structures: The press-working, welding, painting and radiator shops in one and the remainder, along with maintenance area in another.

15. The Anyang plant was initially designed for a capacity of 30,000 sets of automotive components. With some rearrangement of the assembly lines and investment in automation of functions such as coil winding, the capacity at the beginning of 1977 is 40,000 sets with flexibility to increase the production of a specific item at the expense of another. The major facilities have the capacity to produce up to 60,000 sets and with minimum investment in specific items of machinery and additional manpower, the overall capacity can be increased to 60,000 sets. HII's present programs include plans to achieve this increase by 1979 and the necessary investment funds have been provided for in the financial projections.

3. Marine Equipment and Operations

16. HII has been engaged in the operation of a shipping line in the past and recently added a small builidng and repair facility to its operations. HII's shipping line is named in Korea Atlas.

17. The Korea Atlas Line comprises four ocean going vessels described below:

HII: Atlas Line Vessels

Name	Description	Tonnage
Premier	General Cargo/Car Carrier	10,300 DWT (5 holds)
Challenger	Pure Bulk Carrier	19,680 DWT (7 holds)
Carrier	Car/Bulk Carrier	18,110 DWT (7 holds)
Counsellor	Car/Bulk Carrier	20,330 DWT (6 holds)

The four ships, currently operating year-round, are valued at around US$11 million. The ships generally ply the trans-pacific route between Korea/ Japan and the U.S. West Coast.

C. Conclusion

18. HII has made substantial progress, since its inception in 1962. Total revenues increased from around US$2 million in 1971 to US$48 million in 1976 as the Company grew from a small trading operation into a significant manufacturing enterprise. In its Gunpo and Anyang operations, the Company has shown the ability to manage a number of diverse though comparatively simple technologies obtained through overseas licenses. The Gunpo plant incorporates some of the elements of a heavy manufacturing facility so that the Company has some experience that relates to the Heavy Machinery Project. The Gunpo construction experience is transferable to the Project and in addition, as indicated earlier, Gunpo will serve as complement to the Heavy Machinery Project.

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ANNEX 2-4
Table 1

HEAVY MACHINERY PROJECT

PRIMARY FACILITIES AND PROJECTED CAPACITY BUILD-UP AT GUNPO

Facility	Area (m2)	Height (m)	Capacity Measure
Foundry	13,000	10.7	Steel Castings: 20,000 tons
			Iron Castings: 10,000 tons
Forge	3,000	9.0	Forged Steels: 10,000 tons
Light Machine Shop) Crane and Under-carriage Shop	27.000	6.0	Machine Hours 1/: 1,186,000
Heavy Machine Shop	12,000	23.5	Machine Hours 1/: 182,400
Fabrication Shop	20,000	23.5	Fabrication: 60,000 tons
Laboratory	1,000	6.0	-
Warehouse	2,000	10.9	-
Office	12,000	-	-

1/ Based on 3-shift 5,700 hour operation

Capacity Build-up by Key Products

Product	1976 (Actual)	1977	1978	1979
Castings and Forgings (000 tons)	10.0	15.0	20.0	30.0
Chiller (000 Refrigeration tons)	10.0	20.0	25.0	30.0
Crane (Units)	20	40	50	60
Other Construction Machinery (Units)	360	500	700	900
Textile-spinning Machinery (000 ton capacity)	-	70	120	150
Cement Machinery (000 ton capacity)	-	300	500	1,000
Paper Machinery (000 ton capacity)	-	40	50	50
Machine Tools (Units)	-	400	800	1,050

It should be noted that capacity noted against each product is not an absolute constraint on its production as the capacity is fairly general purpose and can be reallocated as necessary.

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CAPACITY OF ANYANG PLANT 1/

Product	Year 76	77	78	79
		(000 Units)		
Heater	40	40	50	60
Shock Absorber	160	200	240	240
Alternator	30	40	60	60
Fuel Tank	40	40	50	60
Ignition Coil	30	40	60	60
Horn	30	40	50	60
Wiper Motor	30	40	60	60
Regulator	30	40	50	60
Starter Motor	30	40	60	60
Side Frame	30	40	50	60
Generator	30	40	50	60
Brake	10	30	45	60
Steering	10	30	45	60
Radiator	40	55	60	60
Car Cooler	1.5	2.0	3.0	3.5
Bus Cooler	0.2	0.4	0.6	0.6

1/ Capacity stated against each product is not an absolute constraint on its production as the facility-balance can be adjusted to make more of one product and less of another.

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HEAVY MACHINERY PROJECT

EXISTING LICENSING AGREEMENTS AND PROGRESS

1. HII's manufacturing operations are based upon the transfer of technology under license agreements with international manufacturers in the U.S.A., France, Germany, Italy and the United Kingdom. Thus far, for its existing plants at Gunpo and Anyang, the Company has negotiated 15 licenses, one of which has expired and another is pending Korean Government approval.

A. The Products

2. The licensing agreements cover the full range of HII's products, currently being manufactured and scheduled for manufacture in 1977 (see Table 1). The products can be categorized into five groups: automotive components; heating and cooling equipment; construction machinery; machine tools; and industrial machinery. For most of these products, the Company has selected licensors from amongst the leading manufacturers in the world. In most cases the technology transferred was new in the Korean context enabling the Company to establish itself as the sole domestic producer.

B. The Nature of the Agreements

3. The agreements are generally licenses that extend for 5 years after the Korean Government has approved them. Thereafter, they can be extended for another 3-5 years subject to Government reapproval. The initial down payment in most cases was quite low based on each model or each set of drawings ranging from US$1,000 for the shock-absorber to US$25,000 for the largest crawler tractor. The royalty paid ranges between 2.5 - 5% averaging around 3% of the sales value. All agreements provide for dispatch of the licensor's engineers at HII's request and expense and in most cases for training of limited HII staff at the licensor's facility. The Company has fully utilized the latter provision as the most effective means of ensuring a smooth transfer of technology.

C. Progress in Production

4. As may be expected, production in the early years was heavily reliant on imported parts and sub-assemblies. HII only contributed 30 - 35% of the total value added, which is still the case for recently introduced construction machinery. However the Company has pursued a rapid localization program and has succeeded in fully localizing the manufacture of some of the automotive components. The manufacture of cranes has been localized to the extent of 60% and along with other construction machinery

is scheduled for around 70% localization by 1979. Some items that are not to be localized because of their specialized nature have been clearly identified. These include components such as master cylinders and other hydraulic systems, engines, special transmission and bearings.

D. Conclusion

5. The Company has gained substantial experience in working with a number of foreign technologies at the same time and has been quite successful at it. Though the technologies involved in the Heavy Machinery Project are much more complex, HII's past experience has been and would continue to be of some value in negotiating licenses for the Project and in setting up the organization necessary to absorb the licensed technologies efficiently. In view of the success of the approach followed in the existing operations, a similar approach, modified for added complexity to include a higher degree of training, a comprehensive program for technology transfer and a more elaborate manufacturing information system, is considered appropriate for the Project.

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KOREA
HEAVY MACHINERY PROJECT
LICENSES FOR EXISTING OPERATIONS

Licensor	Licensed Products	Term	Dates: Govt. Approval	Dates: Expiration
Products Manufactured at Hyundai				
AUTO PRODUCTS				
Mitsubishi (Japan)	Generator, Regulator Ignition Coil, Starting Motor, Wiper Motor, Distributor Horn	3 years from the date of Government approval. (can be extended for 2 years)	4.19.70	1.20.75
Tokico (Japan)	Shock Absorber and Suspension Struts	3 years from the date of Government Approval. Obtained government approval for the extension of 3 years	4.23.70	4.22.76
Girling (U.S.A.)	Braking System & Hydraulic Clutch Actuation Equipment	5 years from the date of Korean Government Approval. Extendible for another 5 years	12.30.74	12.29.79
Burman & Sons (U.K.)	Steering Units for Auto Vehicles	5 years from the date of Korean Government Approval. Extendible for another 5 years	12.30.74	12.29.79
John E. Mitchell (U.S.A.)	Car coolers	Expired; HII now manufacturing under own Brand.		
Products Manufactured at Gunsan				
HEATING & COOLING				
Airtemp (U.S.A.)	Full range of centrifugal and reciprocating central air-conditioning equipment.	Extended for 3 years beyond initial 5 years.	6.22.70	8.25.78
Tokyo Sanyo Electric Co. (Japan)	Absorption type Water chiller	5 years from the date of Gov't approval. Extendable for 5 years	9.01.75	8.31.80
CONSTRUCTION MACHINERY				
American Hoist & Derrick Co. (U.S.A.)	Truck, Cranes, Back Hoes, Derrick & Revolver	5 years from the date of Government approval, extendible	3.13.73	3.12.78
Fiat-Allis Construction (U.S.A.)	Crawler Tractor, Wheel Loader	5 years from the date of Korean Government Approval. Extendible for 5 years	8.16.74	8.15.79
Poclain S.A. (France)	Hydraulic excavator	5 years from the date of Korean Government Approval. Extendible for another 5 years	5.13.74	5.12.79
Allis-Chalmers Co. (U.S.A.)	Forklift Industrial Trucks	5 years from the date of Gov't approval. Extendible for 5 years	5.30.75	5.29.80
MACHINE TOOLS				
Osaka Kiko Co., Ltd. (Japan)	Lathes and Milling Machines	5 years from the date of Government approval. Extendible for 5 years.	4.02.76	4.02.81
INDUSTRIAL MACHINERY				
Marzoli (Italy)	Spinning Machinery	5 years from the date of Korean & Italian Approval	4.16.75	4.15.80
Fuller Co. (U.S.A.)	Cement Machinery	10 years from the date of Korean Government Approval and can be extended another 5 years	9.26.74	9.25.84
Voith GMBH (Germany)	Paper Machinery, full range of products	5 years from the date of Korean Government approval.	Expected before February 77 Agreed 10.05.76	

Industrial Projects Department
February 1977

ANNEX 2-5
TABLE 1

KOREA

HEAVY MACHINERY PROJECT

HII: HISTORICAL INCOME STATEMENTS

(Won Millions)

	1971		1972		1973		1974		1975		1976	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Sales												
Manufacturing	673	57	1,230	61	3,088	62	6,051	63	8,124 5/	71	19,525	85
Marine	506	43	791	39	1,907	38	3,585	37	3,388	29	3,537	15
Sales	1,179	100	2,021	100	4,995	100	9,636	100	11,512	100	23,062	100
Cost of Sales												
Manufacturing 1/	516	44	777	39	2,305	46	4,750	49	6,577	57	14,951	65
Marine	362	31	553	27	762	15	1,576	16	1,468	13	2,074	9
Cost of Sales	878	75	1,330	66	3,067	61	6,326	66	8,045	70	17,025	74
Gross Profit	301	25	691	34	1,928	39	3,310	34	3,467	30	6,037	26
Indirect Expenses												
Selling and Administrative	118	10	214	10	416	8	676	7	973	8	2,026	9
Depreciation	148	12	317	16	768	15	836	9	1,428	12	2,251	10
Interest Expense	81	7	238	12	534	11	830	8	1,007	9	1,957	8
Income from other Sources 2/	(61)	(5)	(159)	(8)	(56)	(1)	(114)	(1)	(281)	(2)	(941)	(4)
Indirect Expense	286	24	610	30	1,662	33	2,228	23	3,127	27	5,293	23
Profit before Taxes	15	1	81	4	266	6	1,082	11	340	3	744	3
Income Taxes 3/	-	-	-	-	-	-	106	1	494	(4)	143	-
Net Profit	15	1	81	4	266	6	976	10	(154)	(1)	601	3
RATIO ANALYSIS												
Debt Service Coverage 4/	1.2		1.5		2.5		2.5		1.2		1.3	
Pre-Tax Return On:												
Average Total Assets	6.9%		9.0%		12.7%		21.6%		8.3%		8.2%	
Average Equity	3.4%		14.2%		33.0%		76.0%		7.7%		11.3%	

1/ Details given in page 2 of this annex.

2/ Income from other sources is chiefly interest income on bank deposits together with sales commissions on a small volume of sales where HII acts as a sales agent.

3/ Income taxes represent taxes actually paid on manufacturing operations, marine operations are exempt from income taxes. In 1975, HII paid taxes of Won 494 million, of which Won 366 million represent income taxes assessed on prior years. No income tax is payable in 1976 since HII is allowed a Won 1490 million investment tax credit on the expansion of its Gunpo plant. The tax credit amounts to 8% of the cost of the new facilities.

4/ Net profit before interest expense and depreciation, divided by: interest expense plus repayment of long term debt.

5/ Of total manufacturing sales in 1976, 44% or Won 8,605 million were to Hyundai Group Companies as follows: Hyundai Motor (22%), Hyundai Construction (15%), Hyundai Ship Building (6%) and Hyundai Cement (1%).

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KOREA

HEAVY MACHINERY PROJECT

HII: HISTORICAL MANUFACTURING COST OF SALES

(Won Millions)

	1971		1972		1973		1974		1975		1976	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Sales	673	100	1,230	100	3,088	100	6,051	100	8,124	100	19,525	100
Cost of Sales												
Labor 1/	119	18	164	13	314	10	651	11	1,143	14	2,964	15
Materials 2/	301	45	462	37	1,635	53	3,467	57	4,444	55	10,019	51
Direct Overheads	77	11	120	10	296	10	482	8	712	9	1,472	7
Royalties and Taxes 3/	19	3	31	3	60	2	150	2	278	3	496	3
Cost of Sales	516	77	777	63	2,305	75	4,750	78	6,577	81	14,951	76
Gross Profit	157	23	453	37	783	25	1,301	22	1,547	19	4,574	24

1/ Labor costs are an abnormally high percentage of sales, 1975-76, due to the build-up in workers required for the start-up of the Company's expanded Gunpo facility which will not be fully on stream until mid-1977.

2/ Material costs are an abnormally high percentage of sales, 1973-75 due to the adding of new product lines over this period particularly in auto parts and construction equipment. By 1976, with a higher sales volume, HII was able to localize production of parts formerly purchased from foreign sources, as well as to realize savings through higher volume purchases of raw materials.

3/ Includes royalties paid to licensors and business tax (1.5%) on sales.

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KOREA

HEAVY MACHINERY PROJECT

HII: HISTORICAL BALANCE SHEETS

(Won Millions)

	1971	1972	1973	1974	1975	1976
ASSETS						
Current Assets						
Cash	136	390	1,167	1,512	2,564	5,821 1/
Accounts Receivable	124	338	460	1,189	1,627	3,699
Inventories						
Raw Materials and Supplies	81	178	964	1,484	1,148	2,442
Goods in Process	37	43	122	260	627	1,882
Finished Goods	60 178	79 300	69 1,155	274 2,018	557 2,332	1,080 5,404
Prepaid Expenses and Other	111	132	440	616	1,296	4,152
Total Current Assets	549	1,160	3,222	5,335	7,819	19,076
Fixed Assets						
Land	212	162	206	332	864	1,654
Building	128	234	405	954	2,370	6,399
Machinery and Equipment	350	757	1,060	2,012	4,756	13,145
Ships	643	3,324	3,410	3,410	8,391 2/	7,344 5/
Total Fixed Assets	1,333	4,477	5,081	6,708	16,381	28,542
Accumulated Depreciation	218	515	1,260	2,037	3,433	3,643
Net Fixed Assets	1,115	3,962	3,821	4,671	12,948	24,899
Investments and Long Term Receivables	28	61	66	79	736	310
Deferred Charges	100	139	195	305	203	235
Total Assets	1,792	5,322	7,304	10,390	21,706	44,520
LIABILITIES AND EQUITY						
Current Liabilities						
Accounts Payable	82	199	401	1,430	1,548	5,927
Short Term Bank Loans	140	361	1,118	1,735	4,652	7,193
Accrued Expenses	477	547	748	1,218	2,104	1,936
Current Portion of Long Term Debt	181	102	233	928	1,758	3,733
Total Current Liabilities	880	1,209	2,500	5,311	10,062	18,789
Retirement Reserve	12	17	36	83	90	667
Long Term Debt	609	3,527	4,049	4,142	6,905	22,030 3/
Less: Current Portion	181	102	233	928	1,758	3,733
	428	3,425	3,816	3,214	5,147	18,297
Equity						
Capital Stock	361	461	461	461	6,000 4/	6,000
Revaluation Surplus				175	175 2/	175
Retained Earnings	111	210	491	1,468	232 4/	592
Total Equity	472	671	952	1,929	6,407	6,767
Total Liabilities and Equity	1,792	5,322	7,304	10,390	21,706	44,520
RATIO ANALYSIS						
Quick Ratio	0.3	0.6	0.6	0.5	0.4	0.5
Current Ratio	0.6	1.0	1.3	1.0	0.8	1.0
Average Turnover						
Accounts Receivable	16.4	8.7	12.5	11.7	8.2	8.7
Accounts Payable	9.0	8.4	9.5	6.4	4.8	4.0
Inventories	3.0	3.3	3.2	3.0	3.0	3.9
Debt/Equity Ratio	48:52	84:16	80:20	62:38	45:55	73:27

1/ Most of the cash carried by HII represents deposits made against short and long-term loans from Korean banks. Each month HII is required to make payments against such loans. The payments are deposited in a bank account on which the company receives interest.

2/ Fixed assets were revalued in 1975 in accordance with the Asset Revaluation Law. The amount of the revaluation, as determined by the Korean Appraisal Board (Ministry of Finance), was W5,620 million, of which W4,785 million represented revaluation of ships which had been purchased in 1972 under depressed market conditions. Of the total revaluation amount, W4,409 million was transferred to share capital, W175 million to revaluation surplus, W167 million was used to pay revaluation taxes, and the balance, W869 million, used to revalue foreign long term debt.

Under the Asset Revaluation Law, assets may be revalued only when the relevant wholesale price index has increased by 25% from the date of the previous revaluation. Also, depreciation for tax purposes is taken on the revalued amount.

3/ Includes foreign debt of W17,234 million valued at exchange rates as of December 31, 1976

4/ Capital stock was increased in 1975 via a stock dividend of W5,539 million, representing: (a) revaluation surplus of W4,409 million and (b) transfers from retained earnings W1,130 million.

5/ Fixed assets and long term debt increase sharply in 1976 due to the expansion of the Company's Gunpo plant.

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KOREA

HEAVY MACHINERY PROJECT

MARKET FOR EXISTING HII OPERATIONS

1. HII's operations can be grouped into the following categories: automotive parts; forging and casting products; space heating and cooling equipment; construction equipment; machine tools; cement, textile and paper machinery; and marine operations. The manufacturing operations are carried out in the Gunpo and Anyang plants under license from reputable international manufacturers (see Annexes 2-4 and 2-5). The marine operations comprise contract and charter voyages on the trans-pacific route. The market prospects and sales plan through 1979 for each of the categories are briefly discussed below. No forecasts are made beyond 1979 since, by that time HII will have reached full capacity operations at both plants.

A. Automobile Parts

2. The demand for motor vehicles in Korea has increased at rates averaging around 27% since 1972 as shown below. For the future the Government projections suggest a rate of 10% and 30% for buses and trucks respectively. The forecasts for passenger cars range from growth rates of 15% to 40% depending upon the cost of ownership and the system of car taxes in effect. The lower figure of 15% would imply a total of 6 to 7 cars per 1,000 persons in 1981, whereas in other countries, at a similar stage of development, registration amounted to 100-150 cars per 1,000 persons.

Korea: Unit Vehicle Demand (000 units)

	1972	1974	1976	Growth Rate 1972-1976	Projected Growth Rate 1976-1981	Projected Demand 1979
Truck	6.5	17.3	18.3	30%	30%	40.2
Bus	2.6	3.9	3.6	8%	10%	4.8
Passenger Car	9.5	9.1	25.9	30%	Low: 10%	34.5
					High: 40%	71.1
	18.6	30.3	47.8	27%	Low: 18%	79.5
					High: 34%	116.1

Source: Ministry of Commerce and Industry

In line with these forecasts, the original equipment manufacturers' (OEM) market for vehicle parts can be expected to range between 80,000 and 120,000 sets in 1979. In light of past performance, a figure between the two extremes of around 100,000 units, implying an aggregate growth rate of 28% is considered reasonable.

3. At the supply end the market for vehicles is serviced by three major manufacturers, Hyundai Motor Company (HMC), Kia Industrial Company, and General Motors Korea (GMK). These began as assembly operations and have subsequently begun integrated manufacture. Under the Government's localization plan, most parts are purchased in the local market. The Government approves domestic manufacturers as suppliers of specific parts and thereafter import of these parts is strictly regulated. HII is the largest approved manufacturer of a wide range of parts under license from overseas manufacturers. For most of these parts HII's only competition is from small manufacturers primarily servicing the replacement market. HII also has the advantage of a captive buyer in its affiliate HMC, the market leader in cars and buses (1976 market share of 57% and 56% respectively.) Consequently HII dominates the original equipment manufacturers market in its range of products, supplying 100% of HMC's requirements, upto 70% of Kia's requirements of specific parts and 90% of KMK's shock absorber requirements. In addition, 10% of HII's sales are directed towards the replacement market for HMC vehicles where it competes against less expensive, lower quality products.

4. HII's past sales record and projections for the future are shown in Table 1. For most products, growth rates ranging up to 70% are evident between 1975 and the annualized sales of 1976. Sales in 1976 were constrained by capacity considerations and, following recent expansion of capacity, are expected to increase sharply in 1977 and 1978, especially for recently introduced items such as brake and steering systems. Thereafter, a more gradual increase of upto around 30% is projected for 1979 corresponding to the increase in vehicle demand. The sales projections for 1979, approximately amounting to 60,000 sets, include sales of around 6,000 to 10,000 sets to the replacement market. Based on these sales forecasts, HII is expected to have a market share of around 50% of the OEM market, which is considered attainable in view of its unique market position.

B. Castings and Forging Products

5. Korea's total requirements for foundry products, primarily cast-iron, amounted to around 230,000 tons in 1974 showing over a 30% annual increase from 1970 figures of 70,000 tons. Demand growth for forgings has been relatively flat, fluctuating around a level of 40,000 tons between 1970-74. Aggregate estimates for 1975-76 indicate a total requirement of castings and forging of 299,000 tons in 1975 and 343,000 tons in 1976. Under the Fourth Plan projections, the requirements for castings are expected to increase markedly in cast-iron products and at a slower rate in cast-steel products. The requirement for forgings is expected to increase above 100,000 tons from its current levels of around 40,000 tons.

These increases are based on projections for the rapid growth of the manufacturing and especially the machinery industry sector in Korea. The projections through 1979, along with planned HII sales are shown in Table 2.

6. Through 1974, HII primarily sold casting and forging products to its affiliates, Hyundai Construction Company, HMC and Hyundai Shipbuilding and Heavy Industry Company. Recently the Company has expanded its market to include custom jobs for outside the Group such as special ingots, motor castings, tire manufacturing molds, parts for cement kilns and pulp machinery. In this field HII faces substantial competition but is helped by its access to low cost, high quality scrap from its affiliated shipyard. HII's sales are expected to grow with the overall demand for forgings and castings. HII sales were 5,800 tons in 1975 and on an annualized basis over 7,600 tons in 1976. In light of this past performance the projected sales increases implying a constant market share are considered reasonable, especially in view of the added capacity at Gunpo.

C. Space Heating and Cooling Equipment

7. HII also manufactures space-heating radiators, car and bus coolers, residential air conditioners and waterchiller-type cooling equipment, under license from international manufacturers. In these products, HII has been successful in localizing the manufacture of a large proportion of the components including the compressors thereby gaining an advantage over other competitors that have to pay import duties on such components. HII's sales plan for these products is presented in Table 3, along with their sales performance for the past two years. The sales of these products are expected to grow quickly due to the expansion of both the Gunpo and Anyang facilities. The sharp increase in the sales of waterchillers is related to the projected increase in demand of such equipment and HII's introduction of the less expensive 100% localized absorption-type water chillers after 1977. HII sales are further supported by strict regulation of the import of such equipment since late 1976 following the demonstration of domestic manufacturing capability.

D. Construction Machinery and Forklift Trucks

8. The Korean construction industry has shown sharp increases in activity in the period between 1965 and 1975. Correspondingly the demand for heavy construction machinery also grew in this period and was met primarily through imports. The levels of construction activity in the past five years and the import status of major items of equipment are shown below.

Korea: Construction Activity and Machinery Imports

	1971	1972	1973	1974	1975	Average Annual Growth
Construction Activity (Won Billions - Current Terms)	229	224	282	446	794	37%
Machinery Imports (Units)						
Bulldozer	193	126	120	205	287	29%
Wheel Loader	84	114	97	126	172	20%
Crane (Mobile)	171	98	103	163	185	--
Excavator	8	14	29	35	42	51%
Motor Grader	10	18	26	46	63	58%
Fork Lifts	220	233	295	441	617	30%

Source: Ministry of Construction.

The demand for cranes has been constrained by the fact that they are classified as heavy transportation equipment and the financing of their imports is controlled by the Government. The sales situation is expected to improve especially as cranes become available domestically.

9. The increase in construction activity is expected to continue into the future at a real rate of around 9% and the demand for construction machinery is projected to grow accordingly. The demand for such machinery is expected to be further spurred by two additional factors, namely, the Government's plan to pave all "national road" surfaces in the country by 1981 and the rapid expansion of overseas activity undertaken by Korean construction companies for which they purchase equipment through Korea. HII's affiliate Hyundai Construction Company is the most active contractor in this area. The projections for sales of construction and other mobile machinery in Korea are presented in Table 4. Growth rates for specific items are assumed to be different in view of the different types of construction activity anticipated and the number of machinery units currently in use in Korea. The table also shows HII's estimates for its own sales of these items which are manufactured under license from internationally known manufacturers. Except for cranes, of which HII only manufactures relatively light units, its products span a wide range and in these product ranges it is the sole domestic manufacturer except for forklifts, where it has one competitor. In addition, the Korean Government recently levied an import restriction on most items of construction machinery, manufactured locally. In view of these circumstances, the implied market shares ranging between 25% and 50% by 1979 are considered attainable.

The only real constraint to these forecasts is capacity and with the expansion at HII's Gunpo facility, this constraint will be removed by early 1977.

E. Machine Tools

10. Concomitant with the development of the mechanical industries in Korea, the requirements for machine tools have risen rapidly. About 70% of domestic requirements primarily comprising precision machinery have historically been imported, the import level rising to about US$60 million in 1975 as shown in the table below. In accordance with the Government's localization policy, domestic production has increased primarily in the low-grade general purpose tools such as low precision lathes and milling machines, keeping pace with the overall growth in the manufcturing index.

Korea: Demand for Machine Tools (Current US$ Millions)

	1971	1972	1973	1974	1975	Average Annual Growth
Production	2.8	2.3	5.5	9.0	10.0	38%
Import	9.1	13.4	18.0	34.2	59.5	60%
Export	0.1	0.3	0.7	0.5	0.2	-
Domestic Demand	11.8	15.4	22.8	42.7	69.3	56%
Manufacturing 1/	100.0	132.0	188.0	276.0	370.0	38%

Source: Korea Society for the Advancement of Machine Industry.

1/ Derived from contribution of Manufacturing to GNP in current terms.

11. HII plans to begin the manufacture of lathes and milling machines in 1977 in its expanded Gunpo facility. Its projected sales in relation to the total demand are shown in Table 5. The demand projections are based on machine tools existing in Korea in 1974 and comparison with other nations. HII plans to establish selling prices at levels equivalent to current c.i.f. prices for imports. As low-grade machine tools which can be manufactured domestically are subject to duties this should provide a significant competitive advantage to HII, making it possible for the Company to contribute significantly to the localization of machine tool production which is expected to reach around 50% of total Korean requirements by 1981.

F. Industrial Machinery

12. Korea has relied on imports for its requirements for industrial plant machinery in the past, though domestic production began to pick up in 1970. According to data obtained from the Ministry of Construction and

Industry, total demand rose from US$.3 billion in 1970 to US$3.3 billion in 1974 showing an average annual increase of over 25% in current dollar terms. Of the total requirement, domestic production accounted for US$0.7 billion in 1970 and US$1.3 billion in 1974. The Government is encouraging domestic production of industrial machinery and HII plans to manufacture equipment for the textile, cement and paper industries under license from Marzoli (Italy), Fuller (U.S.A.) and Voith (Germany) respectively.

1. Textile Machinery

13. Korea is currently one of the world's largest exporters of textiles and garments. These exports have been supported by significant imports of textile machinery. Spinning machinery alone accounted for US$138 million in imports in 1974, up 42% from 1973. There are currently 2.1 million cotton spinning spindles in Korea and under the Government supported expansion plan, licenses have been issued for the installation of one million more in 1977 and 1978. In addition the demand for replacement spindles in this period is projected at 500,000. The demand thereafter is projected to drop. HII, manufacturing under license from Marzoli plans to supply cotton spinning spindles beginning in 1977. Its sales forecasts are reasonable in relation to the estimated demand considering its position as sole domestic manufcturer (see table below).

Korea: Demand[1/] Projections and HII Spindle Sales

	1975	1976	1977	1978	1979
Production of Cotton Yarn (000 tons)	185	248	286	299	316
Demand for Spindles (000s)					
New Installation	-	-	500	500	250
Replacement	-	-	250	250	300
Total	-	-	750	750	550
HII Sales (000 Spindle)	-	-	50	100	150
Unit Price (Won 000 Spindle)	-	-	90	97	105
Sales Amount (Won millions)	-	-	4,500	9,700	15,750

1/ Source: Economic Planning Board

2. Cement Machinery

14. The cement manufacturing industry in Korea has progressed significantly through modernization and expansion of capacity. Korea achieved self-sufficiency in cement in 1970 and has been exporting cement since. The demand for cement in line with the rapid increases in construction activity had grown from 2.4 million tons in 1967 to 8.8 million tons in 1974 at an average annual rate of 21%. In line with further expected increases in domestic demand and exports, the Government is planning for a 5.6 million ton increase in capacity in the Fourth Five-Year Plan between 1977 and 1981. HII plans to supply a part of the machinery required for such an expansion. According to current Korean estimates the machinery cost per annual ton of capacity would amount to US$50, of which HII is capable of supplying 70% (US$35/ton of capacity) the remainder being imported. In addition to the domestic market, since signing of its license agreement with Fuller, HII has been aggressively marketing cement plants in a number of other countries. In view of these factors, the sales forecasts presented below are reasonable.

Korea: Cement Machinery Demand[1/] and HII Sales

	1972	1973	1974	1975	1976	1977	1978	1979
Cement Production (million tons)	6.5	8.1	8.8	10.9	12.5	14.0	14.5	16.8
Installation of Capacity (000 tons)	-	-	1,200	2,200	2,200	-------2,800------- (up to 1981)		
HII Sales (000 tons)	-	-	-	-	-	220	490	650
Unit Price (Won 000/ton capacity, HII supplies machinery	-	-	-	-	-	18	19.5	21
HII Sales Amount (Won millions)	-	-	-	-	-	3,960	9,500	13,580

1/ Source: Economic Planning Board

3. Paper Machinery

15. The paper-making industry in Korea, spurred by domestic demand and the Government's localization policy attained self-sufficiency in 1975, production increasing from 410,000 tons in 1972 to 665,000 tons in 1975. The demand for paper is projected to continue to increase at an average annual rate of 10-12% and it is planned that domestic production capacity increase correspondingly (see Table below). HII plans to manufacture the complete

range of paper-making machinery under license from Voith (German). In the past year HII's domestic project sales staff has been actively negotiating the sale of two plants to local companies totalling 155,000 metric ton capacity, to be installed over the period 1977-79. In this field HII has little competition, the only other manufacturer in Korea being smaller companies catering to plant size in the range of 6,000-10,000 metric ton capacity. Accordingly HII's sales plan presented below should prove to be realistic.

Korea: Paper Demand 1/ and HII Sales Projection

	1972	1973	1974	1975	1976	1977	1978	1979
Paper Demand 1/ (000 tons)	446	558	642	665	757	852	951	1,061
Paper Import	35	35	25	-	-	-	-	-
Demand for New Capacity (000 tons)	-	-	-	-	-	133	120	135
HII Sales (000 tons)	-	-	-	-	-	30	40	50
Unit Price 2/ (Won 000/ton)	-	-	-	-	-	150	162	175
Sales Amount (Won millions)	-	-	-	-	-	4,500	6,580	8,750

1/ Source: Economic Planning Board; includes domestic and export requirements.

2/ Represents c.i.f. prices in 1976 (US$290 - 320/ton including stock-preparation equipment) escalated by the Bank's suggested escalation factors.

G. Marine Operations

16. HII operates the Korea Atlas Shipping line which currently comprises four vessels acquired in 1972, with a total available tonnage of 68,420 dead-weight tons. Except for one pure bulk carrier, the vessels are combination cargo/bulk cariers and generally run the trans-pacific route between the U.S. West Coast and Japan/Korea. The vessels are operated on a contract basis for cargo transport to the U.S. and rely on the spot market for grain transport from the U.S. Currently one vessel is on time charter to the affiliate, Hyundai Construction Company and two have one year contracts for car transport. HII's marine revenues rose steadily between 1971 and 1974 and dropped in 1975 due to a collapse in the market in that year (see table below).

HII Marine Revenues

	1971	1972	1973	1974	1975	1976 Up to 10/31
Revenues (Won millions)	506	791	1,907	3,585	3,388	2,908
Time Charter Rate Index 1/ (Bulk Carriers 10-20,000 DWT)		1.4-2.8	2.8-6.1	6.1-3.6	3.6-1.5	1.5-2.1

1/ Source: Shipping Research Publications

17. The Atlas Line's operations are supported by four overseas offices and cargo brokers and it has been nominated by the Government as one of the six major shipping lines in Korea and is being encouraged to actively participate in the expansion of Korea's shipping activity. An uptrend in the market was expected to generate 1976 revenues of Won 3,600 million. However the projection of its operations into the future can be expected to remain around that level but for changes in charter and other rates. The revenues, assuming only inflationary rises in charter rates are shown below.

Projected Shipping Revenues

	1976	1977	1978	1979
Revenues (Won millions)	3,600	3,890	4,200	4,530

H. Jobbing and Other Sales

18. In addition to the above activities, HII undertakes custom manufacturing and outfitting for local and overseas companies and the Korean Government. This category includes sales of small batches of sintered metal parts, special fabrications for some HII licensors, vehicle-outfitting for the Korean Government and other products not manufactured on a continuous basis.

I. Conclusion

19. A summary of HII's forecast sales is presented in Table 6. The market prospects in all manufacturing areas are excellent spurred by Korea's rapid development in all related sectors. HII with its Gunpo facility in place and its numerous licensing agreements is in a very good position to benefit from the Government's localization policy and thereby contribute significantly to import substitution in most areas. In most of the areas

HII is expected to be for the time being the sole supplier competing only with imports, which are strictly regulated and subject to import duties. In addition it has captive markets in its affiliates. The forecast sales are therefore justifiable, and in instances conservative from the market perspective, being constrained by capacity considerations.

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KOREA
HEAVY MACHINERY PROJECT
HII's PROJECTED SALES FOR AUTO-PARTS
(in Units)

	1975	1976	Unit Prices 1976 (Won 000s)	1977	1978	1979
Heater	14,000	19,500	27.2	30,000	50,000	60,000
Shock Absorber	74,000	125,200	4.5	200,000	240,000	240,000
Fuel Tank	26,000	20,100	9.1	36,000	50,000	60,000
Radiator	47,000	29,000	19.2	46,000	60,000	60,000
Side Frame	6,000	3,700	63.8	15,000	20,000	30,000
Brake	---	4,400	91.4	15,000	30,000	60,000
Steering	---	3,500	46.0	15,000	30,000	60,000
Alternator	26,000	31,300	26.2	40,000	60,000	60,000
Horn	15,000	20,600	2.3	25,000	50,000	60,000
Starter Motor	22,000	30,700	33.4	44,000	60,000	60,000
Regulator	27,000	28,400	7.9	35,000	50,000	60,000
Ignition Coil	18,000	27,700	2.1	30,000	50,000	60,000
Wiper Motor	20,000	30,000	10.5	42,000	50,000	60,000
Generator	5,000	5,800	47.3	35,000		
Others (sales value Won millions)	245.2	934.2		1,860	2,000	2,000
Total Sales Value 1/ (Won millions)	4,093.5	6,331.2		13,300	22,460	31,090

1/ Total sales value beyond 1976 was determined by adjusting 1976 prices according to international price escalation factors.

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ANNEX 2-8
Table 1

KOREA
HEAVY MACHINERY PROJECT
PROJECTED DEMAND AND HII SALES OF FORGINGS & CASTINGS

	Requirement 1/ (000 tons)	HII Market Share 2/ (%)	HII Sales 2/ (000 tons)	Unit Price 3/ (Won 000/ton)	Sales Amount (Won millions)
Iron Casting					
1977	283	2.5	7	260	1,820
1978	355	2.5	8.9	275	2,450
1979	448	2.5	11.0	290	3,190
Steel Casting					
1977	95	3.5	3.4	460	1,550
1978	125	3.9	4.9	495	2,430
1979	170	3.6	6.1	535	3,280
Steel Forging & Other					
1977	53	5.6	3	310	930
1978	62	5.6	3.5	328	1,150
1979	73	6.2	4.5	345	1,550
Total					
1975 4/	299	2.0	5.8	302	1,750
1976 4/	343	2.2	7.6	375	2,860
1977	431	3.2	13.4	320	4,300
1978	542	3.2	17.2	345	5,930
1979	691	3.2	21.6	372	8,020

1/ Source: Korea Development Institute. Requirement = Production + Import - Export
2/ HII estimates.
3/ Prices are derived by applying international escalation factors and local considerations to 1976 prices.
4/ Figures for 1975 and 1976 demand are aggregate estimates; HII sales figures are actual data.

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ANNEX 2-8
Table 2

KOREA
HEAVY MACHINERY PROJECT
PAST AND PROJECTED HII SALES OF SPACE CONDITIONERS

	Demand 1/	HII Sales (units)	Unit Price 2/ (Won 000/unit)	Sales Value (Won millions)
Radiators				
1975		18,175	13	245
1976		70,740	4.4	314
1977	N.A.	40,000	5.0	200
1978		60,000	5.0	300
1979		75,000	5.0	375
Car Coolers				
1975		213	348	74
1976		400	335	134
1977	N.A.	1,000	337	337
1978		1,500	363	544
1979		3,000	393	1,179
Bus Coolers				
1975		48	3,790	181
1976		75	3,906	292
1977	N.A.	300	4,100	1,230
1978		500	4,430	2,215
1979		600	4,780	2,868
Water Chillers				
1975	20,000	2,400	140	336
1976	30,000	2,490	80	198
1977	40,000	17,600	45	900
1978	50,000	25,000	50	1,250
1979	80,000	30,000	55	1,650

1/ Demand and HII sales are in units except for water chillers, where they are in refrigeration-tons.

2/ Unit prices shown are per unit for radiators and coolers and per refrigeration-ton for chillers and have been derived by applying the international price escalation factors and allowing for real price decreases in the early years for some products.

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KOREA
HEAVY MACHINERY PROJECT

1/
DEMAND FORECAST & HII SALES OF CONSTRUCTION MACHINERY (Units)

	Actual HII Sales		Forecast								
			1977			1978			1979		
	1975	1976	Demand	HII Sales	Unit Price 2/	Demand	HII Sales	Unit Price 2/	Demand	HII Sales	Unit Price 2/
Bull Dozer	8	44	360	100	59	400	150	70	440	200	75
Wheel Loader	10	66	290	120	34	310	140	39	340	160	42
Excavator	6	15	130	30	51	180	65	54	200	100	58
Crane	3	8	320	25	73	350	50	79	380	60	86
Fork Lift	13	11	580	200	13	630	300	14	600	350	15
Motor Grader	--	11	150	30	36	180	40	43	200	50	46
Dozer Tracks	--	160	900	300	3.1	1,100	400	3.9	1,500	600	4.1
Total Sales (Won millions)	1,290	7,510		17,810			29,640			42,690	

1/Demand forecast source: Ministry of Construction; and Construction Association of Korea.

2/Unit Prices expressed in Won millions are generally derived by applying international price escalation factors to 1976 prices and adjusting for product-mix changes.

Industrial Projects Department
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ANNEX 2-8
Table 4

KOREA

HEAVY MACHINERY PROJECT

MACHINE TOOLS FORECAST

Item	Year	Estimated Demand 1/ in Korea (Units)	Projected Sales of HII (Units)	HII Market Share	Unit Price (Won million)	Sales Amount (Won million)
LATHE	1977	5,700	100	1.75%	6	600
	1978	7,100	200	2.8%	6.5	1,300
	1979	8,900	300	3.4%	7.0	2,100
MILLING M/C	1977	4,000	70	1.8%	10	700
	1978	5,000	200	4.0%	10.8	2,160
	1979	7,000	300	4.3%	11.7	3,510

1/ Source: Korea Institute of Science & Technology.

Industrial Projects Department
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ANNEX 2-8
Table 5

ANNEX 2-8
Table 6

KOREA

HEAVY MACHINERY PROJECT

HII SALES FORECAST FOR EXISTING OPERATIONS

(Won Millions)

Item	1975	1976	1977	1978	1979
Auto Parts	4,090	6,330	13,300	22,460	31,090
Forgings and Castings	1,750	2,860	4,300	5,930	8,020
Space Conditioners	850	940	2,670	4,310	6,070
Construction Machinery	1,290	7,510	17,810	29,640	42,690
Machine Tools	-	-	1,300	3,460	5,610
Industrial Machinery	-	1,020	17,630	25,680	38,080
of which:					
Textile	-	-	(4,500)	(9,700)	(15,750)
Cement	-	(195)	(3,960)	(9,500)	(13,580)
Paper	-	-	(4,500)	(6,480)	(8,750)
Other 1/	-	(825)	(4,670)	-	-
Jobbing and Other Sales	140	860	1,300	2,500	3,000
Total Sales Manufacturing	8,120	19,520	58,310	93,980	134,560
Total Sales Marine Operations	3,390	3,540	3,890	4,200	4,530
Total Sales	11,510	23,060	62,200	98,180	139,090

1/ Parts for a combined cycle power plant

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KOREA

HEAVY MACHINERY PROJECT

HII: FINANCIAL PROJECTIONS (WITHOUT PROJECT)

Financial projections for HII's existing operation, 1977-1986 are detailed in pages 2 through 5 of this annex. Sales forecasts are based on the assessment of market demand given in Annex 2-8. Assumptions for the projected income statements and balance sheets are detailed in the footnotes to these statements.

KOREA

HEAVY MACHINERY PROJECT

INCOME STATEMENT (WITHOUT PROJECT)
(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
SALES 1/											
MANUFACTURING	19.50	58.30	94.00	134.60	144.00	154.10	164.80	176.40	188.70	201.90	216.10
MARINE	3.60	3.90	4.20	4.50	4.90	5.20	5.60	5.90	6.40	6.80	7.30
SUB-TOTAL	23.10	62.20	98.20	139.10	148.90	159.30	170.40	182.30	195.10	208.70	223.40
COST OF SALES 2/											
LABOR	3.00	5.48	8.74	11.44	13.10	14.95	17.30	19.93	22.83	26.25	30.25
MATERIALS	10.00	31.77	48.22	65.28	69.84	74.74	79.93	85.55	91.52	97.92	104.81
DIRECT OVERHEAD	1.50	4.66	7.52	10.77	11.52	12.33	13.18	14.11	15.10	16.15	17.29
ROYALTIES AND TAXES	.50	1.75	2.82	4.04	4.32	4.62	4.94	5.29	5.66	6.06	6.48
TOTAL MFG COST OF SALES	15.00	43.67	67.30	91.53	98.78	106.64	115.36	124.89	135.11	146.38	158.83
MARINE COST OF SALES	2.10	2.34	2.52	2.70	2.94	3.12	3.36	3.54	3.84	4.08	4.38
TOTAL COST OF SALES	17.10	46.01	69.82	94.23	101.72	109.76	118.72	128.43	138.95	150.46	163.21
GROSS PROFIT											
GROSS PROFIT	6.00	16.19	28.38	44.87	47.18	49.54	51.68	53.87	56.15	58.24	60.19
INDIRECT EXPENSES											
SELLING AND ADMIN. 3/	2.00	5.60	8.84	12.52	13.40	14.34	15.34	16.41	17.56	18.78	20.11
DEPRECIATION AND AMORT. 4/	2.20	3.40	4.00	3.70	3.30	2.90	2.60	2.30	2.10	1.80	1.60
INTEREST EXPENSES 5/	2.00	2.90	2.60	2.20	1.90	1.20	1.00	.80	.60	.50	.40
INCOME FROM OTHER SOURCES	(.90)	(.62)	(.98)	(1.39)	(1.49)	(1.59)	(1.70)	(1.82)	(1.95)	(2.09)	(2.23)
TOTAL INDIRECT EXPENSES	5.30	11.28	14.46	17.03	17.11	16.84	17.23	17.68	18.31	19.00	19.87
PROFIT											
PROFIT BEFORE TAXES	.70	4.92	13.92	27.84	30.06	32.70	34.45	36.18	37.84	39.25	40.31
INCOME TAXES 6/	.10	1.18	6.75	13.50	14.58	15.86	16.71	17.55	18.35	19.03	19.55
INVESTMENT TAX CREDIT	-	-	-	-	-	-	-	-	-	-	-
NET PROFIT	.60	3.73	7.17	14.34	15.48	16.84	17.74	18.64	19.49	20.21	20.76

1/ Details of sales forecasts are given in Annex 2-8.

2/ Manufacturing cost of sales details are given on page 3 of this Annex. Marine cost of sales are forecast at 60% of marine revenues.

3/ Forecast at 9% of sales, in line with past experience.

4/ HII depreciates fixed assets on a declining balance basis at the same rates allowed for tax purposes. No depreciation is taken on fixed asset additions during the year. The annual depreciation charge is thus based on net fixed assets at the end of the previous year. Depreciation rates used are as follows: Buildings (5.6%), machinery and equipment (18.9%), ships (17.5%). Amortization of deferred charges is also on a declining balance basis (33% each year) in accordance with Korean tax law. It is assumed that no revaluation of assets which are periodically allowed under Korean tax law, will occur during the Forecast period.

5/ Forecast at 1% of sales.

6/ Korean income taxes are 50% of profit before taxes. Marine operations are exempt from income tax. Thus, overall HII's taxes will average about 48.5% of pre-tax income. In 1976 and 1977, taxes are further reduced by the 8% investment tax credit on the cost of fixed assets for the Gunpo expansion. The total tax saving in these two years amounts to Won 1.5 billion. If HII were to go public, as planned, after 1983, its tax rate would be reduced to the 38% preferential rate for public companies.

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KOREA

HEAVY MACHINERY PROJECT

HII: PROJECTED COST OF SALES FOR MANUFACTURING (WITHOUT PROJECT)
(Won Billions)

	1976		1977		1978		1979		1980		1981	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Sales[1]	19.5	100	58.3	100	94.0	100	134.6	100	144.0	100	154.1	100
Cost of Sales												
Labor[2]	2.9	15	5.5	9	8.7	9	11.4	8	13.1	9	15.0	9
Materials[3]	10.0	51	31.8	55	48.2	51	65.3	49	69.8	49	74.7	49
Direct Overhead[4]	1.5	7	4.7	8	7.5	8	10.8	8	11.5	8	12.3	8
Royalties and Taxes[5]	0.5	3	1.7	3	2.8	3	4.0	3	4.3	3	4.6	3
Cost of Sales	14.9	76	43.7	75	67.2	71	91.5	68	98.7	69	106.6	69
Gross Profit	4.6	24	14.6	25	26.8	29	43.1	32	45.3	31	47.5	31

	1982		1983		1984		1985		1986	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Sales[1]	164.8	100	176.4	100	188.7	100	201.9	100	216.1	100
Cost of Sales										
Labor[2]	17.3	10	19.9	11	22.9	12	26.3	13	30.3	14
Materials[3]	79.9	49	85.6	49	91.5	49	97.9	49	104.8	49
Direct Overhead[4]	13.2	8	14.1	8	15.1	8	16.2	8	17.3	8
Royalties and Taxes[5]	4.9	3	5.3	3	5.7	3	6.1	3	6.5	3
Cost of Sales	115.3	70	124.9	71	135.2	72	146.5	73	158.9	74
Gross Profit	49.5	30	51.5	29	53.5	28	55.4	27	57.2	26

1/ Sales forecast, 1977-79, is detailed in Annex 2-8, Table 7. For 1980-86, sales are assumed to grow at 7% annually to reflect inflation beyond the 1979 steady state. Inflation rates used are estimated international inflation rates for machinery and equipment.

2/ Labor costs are based on HII's manpower plan for the 1977-79 period. Labor costs drop as a % of sales in 1977 reflecting the utilization of labor built up in advance, 1975-76, to support the Gunpo expansion. Labor costs are assumed to inflate 20% annually, 1977-79, and 15% annually, 1980-86, to reflect the expected real gains in Korean wage rates as development proceeds.

3/ Forecast material costs for existing product lines are based on actual 1976 costs as per HII's cost accounting records. For new products (chiefly machine tools and industrial machinery) material costs are based on material lists and production drawings obtained from licensors. In 1977 and 1978, in order to reflect inefficiencies in raw material usage and a greater reliance on bought-out parts, unit material costs for new products have been increased above those used for the 1979 steady state. For this reason, and because of an increase in sales mix towards items with a high bought-out parts content (construction machinery and industrial machinery) versus items with low bought-out parts (auto parts), material costs as a percentage of sales are significantly higher in 1977 than in 1976. Material costs as a percentage of sales decrease in 1978 and 1979, however, increasing efficiencies in material usages for new products is partially offset by a continued sales trend towards items with higher levels of bought-out parts. Inflation of material costs is assumed to be at the same rate as sales inflation.

4/ Forecast at 8% of sales, in line with historical results.

5/ Forecast at 3% of sales, in line with historical results.

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KOREA

HEAVY MACHINERY PROJECT

BALANCE SHEET (WITHOUT PROJECT)

(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ASSETS											
CURRENT ASSETS 1/											
MINIMUM CASH	5.80	1.24	1.96	2.78	2.98	3.19	3.41	3.65	3.90	4.17	4.47
ACCOUNTS RECEIVABLES	3.70	9.33	13.26	16.69	17.87	19.12	20.45	21.88	23.41	25.04	26.81
ADVANCES TO SUPPLIERS	-	1.59	1.93	1.96	2.10	2.24	2.40	2.57	2.75	2.94	3.14
INVENTORIES											
MATERIALS AND SUPPLIES	2.40	6.99	9.64	10.90	11.66	12.48	13.35	14.29	15.28	16.35	17.50
WORK IN PROGRESS	3.00	10.49	16.92	21.54	23.04	24.66	26.37	28.22	30.19	32.30	34.58
TOTAL INVENTORIES	5.40	17.48	26.56	32.44	34.70	37.14	39.72	42.51	45.48	48.66	52.08
PREPAID EXPENSES AND OTHER	4.20	3.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
TOTAL CURRENT ASSETS	19.10	32.65	47.71	58.87	62.64	66.68	70.97	75.60	80.54	85.81	91.50
SURPLUS CASH	-	(2.36)	(.69)	7.30	18.04	32.99	48.61	65.32	83.39	102.22	121.11
FIXED ASSETS 2/											
GROSS FIXED ASSETS	28.50	34.30	35.50	36.60	37.60	38.50	39.50	40.40	41.20	42.10	42.90
ACCUM. DEPRECIATION	3.60	6.90	10.60	13.90	16.80	19.30	21.50	23.50	25.20	26.90	28.30
NET FIXED ASSETS	24.90	27.40	24.90	22.70	20.80	19.20	18.00	16.90	16.00	15.20	14.60
INVESTMENTS L-T RECEIVABLES	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30
DEFERRED CHARGES											
GROSS DEFERRED CHARGES	.40	.70	1.20	1.80	2.30	2.70	3.00	3.20	3.40	3.50	3.70
ACCUM. AMORTIZATION	.20	.40	.60	1.00	1.40	1.80	2.20	2.50	2.80	3.10	3.30
NET DEFERRED CHARGES	.20	.30	.60	.80	.90	.90	.80	.70	.60	.40	.40
TOTAL ASSETS	44.50	58.29	72.82	89.97	102.68	120.07	138.68	158.82	180.83	203.93	227.90
LIABILITIES AND EQUITY											
CURRENT LIABILITIES 1/											
ACCOUNTS PAYABLE	5.90	10.32	14.16	17.08	18.42	19.86	21.45	23.17	25.04	27.08	29.33
ADVANCES FROM CUSTOMERS	-	7.00	12.22	14.81	15.84	16.95	18.13	19.40	20.76	22.21	23.77
S-T BANK LOAN	7.20	2.54	2.54	2.54	-	-	-	-	-	-	-
ACCRUED EXPENSES	2.00	4.00	5.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
CURR. PORTION OF LT DEBT	3.70	3.00	4.10	2.90	2.30	2.20	1.80	.90	.90	.90	.80
TOTAL CURR. LIABILITIES	18.80	26.96	38.02	43.33	42.56	45.01	47.38	49.48	52.70	56.19	59.90
RETIREMENT RESERVE 3/	.60	.90	1.20	1.60	1.90	2.20	2.50	2.80	3.00	3.30	3.60
LONG-TERM DEBT											
TOTAL LONG-TERM DEBT	22.00	23.00	20.90	15.90	13.00	10.70	8.50	6.70	5.80	4.90	4.00
CURRENT PORTION	3.70	3.00	4.10	2.90	2.30	2.20	1.80	.90	.90	.90	.80
NET LONG-TERM DEBT	18.30	20.00	16.90	13.00	10.70	8.50	6.70	5.80	4.90	4.00	3.20
EQUITY											
CAPITAL STOCK	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
REVALUATION SURPLUS	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
RETAINED EARNINGS	.60	4.33	11.50	25.84	41.32	58.16	75.90	94.54	114.03	134.24	155.00
TOTAL EQUITY	6.80	10.53	17.70	32.04	47.52	64.36	82.10	100.74	120.23	140.44	161.20
TOTAL LIABILITIES AND EQUITY	44.50	58.29	72.82	89.97	102.68	120.07	138.68	158.82	180.83	203.93	227.90

1/ Working capital assumptions are detailed on page 5 of this Annex.

2/ Increases in fixed assets represent the completion of the Gunpo expansion in 1977, and normal capital expenditures thereafter.

3/ Under Korean tax law, companies are required to set up a reserve for severance pay upon retirement of staff. Total amount of the reserve is limited to 10% of annual salaries.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

HII: PROJECTED WORKING CAPITAL REQUIREMENTS (WITHOUT PROJECT)
(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Current Assets											
Minimum Cash 1/	5.80	1.24	1.96	2.78	2.98	3.19	3.41	3.65	3.90	4.17	4.47
Accounts Receivable 2/	3.70	9.33	13.26	16.69	17.87	19.12	20.45	21.88	23.41	25.04	26.81
Advances to Suppliers 3/	-	1.59	1.93	1.96	2.10	2.24	2.40	2.57	2.75	2.94	3.14
Inventory											
Materials and Supplies 4/	2.40	6.99	9.64	10.90	11.66	12.48	13.35	14.29	15.28	16.35	17.50
Goods in Process and Finished Goods 5/	3.00	10.49	16.92	21.54	23.04	24.66	26.37	28.22	30.19	32.30	34.58
	5.40	17.48	26.56	32.44	34.70	37.14	39.72	42.51	45.48	48.66	52.08
Prepaid Expenses and Other	4.20	3.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Total Current Assets	19.10	32.65	47.71	58.87	62.64	66.68	70.97	75.60	80.54	85.81	91.50
Current Liabilities											
Accounts Payable 6/	5.90	10.32	14.16	17.08	18.42	19.86	21.45	23.17	25.04	27.08	29.33
Advances from Customers 7/	-	7.00	12.22	14.81	15.84	16.95	18.13	19.40	20.76	22.21	23.77
Short Term Bank Loans 8/	7.20	2.54	2.54	2.54	-	-	-	-	-	-	-
Accrued Expenses	2.00	4.00	5.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Total Current Liabilities	15.10	23.86	33.92	40.43	40.26	42.81	45.58	48.58	51.80	55.29	59.10
Working Capital	4.00	8.79	13.79	18.44	22.38	23.87	25.49	27.02	28.74	30.52	32.40

NOTE: For the purpose of calculating working capital requirements, HII's existing operations have been divided into two areas: the manufacture of long lead time products (industrial machinery, representing about 30% of sales) and the manufacture of short lead time products (all other items). The working capital requirements on both types of products are quite different. More details on the assumptions for working capital requirements for long-lead time products are given in Annex 5-2.

Also, it should be noted that turnovers of accounts receivable, inventories, and accounts payable will be lower than normal in the early years of the Gunpo expansion when sales and related costs are increasing throughout the year. Normal turnovers will be achieved in 1979 and later years when revenues and expenses have reached steady-state levels.

1/ Forecast at 2% of sales.

2/ Short lead-time products: Assumed turnovers as follows: 7.0 times (1977), 8.0 times (1978), 9.0 times thereafter. Average turnover on HII's accounts receivable in 1976 was 8.7 times.

Long lead-time products: Turnover of accounts receivable for progress billings (80% of sales value): same as for short-lead time products. Turnover of accounts receivable representing holdbacks (20% of sales value): 2.0 times on the first 10%, 1.0 times on the second 10%.

3/ Long lead-time products only: 20% of following year's bought-out parts.

4/ Short and long lead-time products: Assumed turnovers are as follows: 4.5 times (1977), 5.0 times (1978), 6.0 times thereafter. Average turnover on HII's materials inventory in 1976 was 5.6 times.

5/ Short lead-time products: Assumed turnovers are as follows: 6.0 times (1977), 6.5 times (1978), 7.0 times thereafter. Average turnover on HII's goods in process in 1976 was 7.2 times.

Long lead-time products: Assuming an average manufacturing period of 6 months, turnovers are forecast as follows: 2.5 times (1977), 2.5 times (1978), 3.0 times thereafter.

6/ Short and long lead-time products: Assumed turnovers are as follows: 4.0 times (1977), 4.5 times (1978), 5.0 times thereafter. Average turnover on HII's accounts payable in 1976 was 4.0 times.

7/ Long lead-time products: 80% of the sales value of long-lead time goods in process, plus 10% of the following year's sales of such items. The latter amount represents deposits received on orders placed by customers.

8/ Short-term bank loans are assumed to be paid-off in 1980

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

THE MACHINERY SECTOR

A. Economic Setting

1. The Republic of Korea is a small densely populated country with a total land area of 99,000 square kilometers. Its topography and harsh winters limit the productive potential of agriculture, only about 23% of the land being cultivated. Korea's mineral resources, principally low quality anthracite coal, are not of great value. Despite these constraints, Korea has established an outstanding record of economic growth, aggregate real GNP increasing at an average rate of around 10% per year since 1962. The rapid growth has been based on the expansion of exports of manufactured goods and has transformed the structure of the economy as shown below.

KOREA: Structure of GNP (1961-1975)
(Won billions, 1970 prices)

	% GNP at 1970 Prices				Annual growth % p.a.		
Sector	1961	1966	1971	1975	1961-66	1966-71	1971-75
Agriculture, forestry forestry, fishery	44.1	38.9	26.5	21.9	5.1	2.3	4.7
Mining, quarrying	1.4	1.4	1.1	1.1	9.2	4.8	8.7
Manufacturing	10.6	14.5	23.3	31.9	14.7	21.4	18.8
Social overhead sectors 1/	6.1	9.0	12.9	13.7	16.9	18.7	11.2
Other 2/	37.8	36.2	36.2	31.4	6.7	10.4	6.1
Total	100.0	100.0	100.0	100.0	7.7	10.5	9.8
Total GNP	1,130	1,720	2,830	4,110			

1/ Includes construction, transportation, storage, communication, electricity, water and sanitary services.

2/ Includes trade, banking, insurance, public administration, defense and other services.

Source: Bank of Korea

The rapid growth in the manufacturing sector, at about twice the rate of growth in aggregate GNP, has resulted in a decline of the share of other sectors in the GNP.

2. The leading edge of this growth and transformation has been the increases in manufactured exports. The share of net manufactured exports to GNP has risen from 1.1% in 1965 to 10.7% in 1975. In 1975, manufactured exports accounted for around 83% of Korea's total commodity exports. This period has also seen marked shifts in the composition of manufactured exports. The share of crude intermediate materials in the export product-mix dropped significantly as a number of higher value added commodities demanding more sophisticated production techniques have gained in prominence: among these are transport equipment, industrial machinery, and a variety of chemicals and precision instruments.

3. Korea's extraordinary export performance is reflected in the changing structure of the manufacturing sector in the last decade, as shown below. Between 1961 and 1975, the heavy manufacturing sector has gained while food processing industries declined in importance. The most notable increase is in the share of machinery and equipment, especially between 1971 and 1975.

Korea: Composition of Gross Manufacturing Output
(% of Total)

	1961	1966	1971	1975
Light Manufacturing				
Food, beverage, tobacco	33.8	27.6	25.0	17.0
Textile, clothing, footwear	28.5	23.9	25.6	32.1
Various light manufactures 1/	15.4	17.9	16.0	15.3
Heavy Manufacturing				
Chemical, coal, petroleum	7.1	11.6	15.5	12.0
Basic metals and metal products	5.8	7.0	6.1	6.7
Machinery and equipment 2/	7.9	10.2	9.3	14.6
Miscellaneous	1.5	1.9	2.5	2.5
Total	100.0	100.0	100.0	100.0
Total Manufacturing Output (Won Billion at 1970 prices)	393.5	789.3	2,041.7	4,290.9

1/ Includes wood and wood products, furniture, paper and paper products, printing, leather and rubber products, clay, glass and stone and plastic products.
2/ Includes electronics and transport equipment.

Source: Bank of Korea, Economic Statistics Yearbook

Machinery and equipment increased from 9.3% of gross manufacturing output in 1971 to 14.6% in 1975, accounting for over 4% of GNP.

B. The Machinery Sector and Industry

4. The Machinery sector in Korea includes the electronics, shipbuilding and machinery building industries. The sector as a whole has been the focus of development emphasis since the late sixties. The performance of this sector since 1969 is shown below.

KOREA: Development of Machinery Sector 1/
(Unit: US$ millions, current prices)

	1969	1970	1971	1972	1973	1974	1975	Growth % 1971-75
Requirement 1/	1,166	1,210	1,317	1,565	2,635	3,990	4,304	34
Production	507	555	554	733	1,384	2,007	2,408	44
Imports	659	655	763	832	1,251	1,983	1,896	25
Exports	51	66	116	194	470	886	889	66
Ratio 2/ of Imports (%)	56.5	54.1	59.9	53.2	47.5	49.7	44.1	

1/ Includes shipbuilding and electronics

2/ Requirement = Production + Imports; Used as a basis to calculate % Imports.

Source: Ministry of Commerce and Industry (MCI); Korea Society for the Advancement of Machine Industry

The sector has grown at very high rates in terms of both, production and export performance. The growth, which has been most dramatic since 1972, was spurred by an investment outlay of Won 542 billion (at 1975 prices) or 19.3% of the total outlay for the manufacturing sector, in the third Five-Year Plan (1972-76). However, almost half of this investment was allocated to the ship-building and electronics industries, which contribute the bulk of the exports from the sector.

5. The machinery sector has also gained in economic importance in terms of employment generation. Employment in the sector more than doubled since 1971 and also increased as a proportion of employment in the total manufacturing sector as shown below:

KOREA: Employment in Machinery Sector
(Number of establishments, 000 employees)

	1971	1972	1973	1974	1975	Growth Rate (%) 1971-75
Manufacturing:						
Establishments	23,412	23,729	23,293	22,632	22,400	(1)
Employees	849	973	1,158	1,298	1,438	14
Employees/ Establishment	36	41	50	57	64	-
Machinery:						
Establishments	3,719	3,860	3,760	4,059	4,100	7
Employees	144	172	228	280	329	23
Employees/ Establishment	39	45	61	69	80	-
Ratio of Machinery/ Manufacturing Employment %	17.0	17.7	19.7	21.6	22.9	-

Employment in the machinery sector has grown at the rate of 23% as against only 14% for the manufacturing sector as a whole. The number of establishments in the machinery area has also been increasing, while those in the manufacturing sector has declined. A trend towards larger establishments in the sector, reinforced by the inclusion of the shipping industry, is also evident. Within the machinery sector, the machinery building industry itself accounted for 2,419 establishments with an estimated 129,000 employees or 39% of the employment in the machinery sector.

6. The breakdown within the machinery sector by 1975 output is approximately: machinery building 50%, shipbuilding 12% and electronics 38%. The performance figures revised to exclude shipbuilding and electronics are shown in the following table. The export performance in the machinery building industry, though registering high growth rates because of a small base, has lagged behind the machinery sector as a whole. In 1975, only 21% of the production was exported as against 37% for the sector i.e. after including shipbuilding and electronics. However, the performance is commendable, since most of the growth occured in the mid-seventies, while international trade was affected adversely by the oil crisis.

KOREA: Development of Machinery Building Industry 1/
(Unit: US$ millions, current prices)

	1970	1971	1972	1973	1974	1975	1976 3/	Growth Rate % 1971-75
Requirement 2/	842	876	948	1,522	2,161	2,571	3,272	36
Production	396	338	402	676	1,021	1,206	1,723	44
Imports	446	538	546	846	1,140	1,365	1,549	30
Exports	18	23	53	129	245	257	417	67
Ratio 2/ of Imports %	52.9	61.4	57.5	55.5	52.7	53.0	47.3	
Ratio of Exports to Production %	4.5	6.8	13.2	19.1	23.9	21.3	24.2	

1/ Excludes electronics and shipbuilding.

2/ Requirement = Production + Imports; Used as a basis to calculate % Imports.

3/ Estimates for 1976

Source: MCI; Korea Society for the Advancement of Machine Industry

7. In order to consider Korea's performance in the manufacture of the heavy class of industrial machinery and plant equipment, which is the area relevant to the Project, a further breakdown is necessary and is shown in the following table.

KOREA: Machinery Building Sub-sector Performance (1976 est.)
(US$ millions)

Sub-sector	Requirement	Production	Imports	Exports	Ratio of 1/ Imports %
General Machinery (Includes industrial plants)	1,403	371	1,032	90	74
Electrical Machinery	764	497	267	120	35
Transport Equipment	896	765	131	68	15
Precision Machinery	209	90	119	140	57
Total	3,272	1,723	1,549	418	47

1/ Requirement = Production + Import; Used as a basis to calculate Import %.

Source: MCI; Korea Society for Advancement of Machinery Industry.

The general machinery sub-sector which includes industrial machinery and plant equipment amongst other items, contributed only 21% of the output and was the most import-dependent (74%) of all sub-sectors.

8. In terms of physical structure and location, around 80% of the establishments are estimated to employ under 50 workers, and around 60% of them are located in and around the metropolitan centers of Seoul and Pusan. The companies in the sub-sector are largely privately held, the larger enterprises being owned by family groups. The Government strategy in this regard has been to encourage the private sector's development. In case of priority projects, such as the HII Project, the Government selects the private enterprise most capable of successfully implementing the project. Companies sponsoring such projects and other large companies are also being encouraged to distribute ownership to the public. This measure is reinforced with a large tax incentive, the corporate tax-rate dropping from 50% to 34% when a closely held corporation goes public. This pattern of private ownership has generally worked well, though due to lack of coordination, it has led to fragmentation of capacity.

9. In summary, the machinery building industry has lagged behind the machinery sector as a whole, due to the focus on electronics and shipbuilding. Further, in the relatively capital-intensive industrial machinery sub-sector, the country has continued to rely on imports as it concentrated development attention on industrial activities of lower capital intensity where it enjoyed a comparative advantage in export markets. Centralized investment planning has not occurred in the sector due to the extreme heterogeneity of the products, and has led to a structure with fragmented capacities and assembly-type operations. There are only a limited number of companies engaged in manufacture of the heavy class of machinery and equipment and these are yet to fully develop local design and technological capabilities. A list of the companies engaged in heavy manufacturing is given in Table 1. HII, with its expanded Gunpo facility, is one of them. In terms of products, rolling stock in the transportation sub-sector and the larger items of construction machinery represent the heaviest and most complex products currently manufactured. The Project would thus represent a significant advance on this front.

C. Fourth Plan Targets

10. The basic strategy of the fourth Plan (1977-81) is an extension of the high-growth pattern (9.2% increase in GNP per year) of the previous plans with increased emphasis on high technology items. As in the past exports are expected to be the driving economic force. The table below shows a comparison between the second, third and fourth Plans in relation to manufacturing. Performance in value-added terms in the manufacturing sector has exceeded past plans and the sector is planned to receive continuing emphasis, receiving 23.2% of the total investment outlay.

KOREA: Manufacturing Sector, 2nd, 3rd and 4th Plans
(Billion Won)

	Second Plan (1967-71)		Third Plan (1972-76)		Fourth Plan (1977-81)
	Planned	Actual	Planned	Actual 1/	
Investment					
Total	980.1	1,984.2	4,524.5	3,774.1	16,695.0
In Manufacturing	283.5	424.9	1,235.3	769.9	3,874.0
Share of manufacturing in total (%)	28.9	21.4	27.3	20.4	23.2
Growth of Value-Added					
Total	335.7	648.1	1,438.9	1,280.9	5,266.0
In Manufacturing	122.3	282.0	528.5	652.0	2,592.0
Share of manufacturing in total (%)	36.4	43.5	36.7	50.9	49.2

1/ Covers 1972 to 1975 only.

Note: Figures for the 2nd, 3rd and 4th FYPs are in 1965, 1970 and 1975 prices respectively.

Source: Respective Plan Documents; EPB, Korea Statistical Yearbook, 1972; BOK, Economic Statistics Yearbook, 1976.

11. Within the sector, the government plans to continue its emphasis on the heavy and chemical industries, for the country to become more self-sufficient in intermediate and capital goods industries and to expand and diversify export into higher value-added goods. In constant terms, the sector output is planned to grow at around 14% a year with the machinery building industry growing much more rapidly at a rate of around 22%. For a detailed breakdown see Table 2. The machinery and electronics industries are planned to receive more investment emphasis with corresponding reductions in textiles and shipbuilding. The prospective growth of the machinery industry excluding shipbuilding and electronics is presented below, leading to total exports of US$1.4 billion by 1981 and a reduction in the import ratio to under 30%. The increase in exports represents an average annual growth of 32% and incorporates export of heavy manufactured goods. The relationship of these exports to total exports is shown in Table 3.

D. Government Strategy for the Machinery Building Industry

12. Promotion of the machinery building industry is especially emphasized in the fourth Plan. Machinery products are planned to be developed for import substitution as well as export. The development is to be supported through a number of incentives related to foreign capital and technology inducement and domestic industry promotion through funds assistance. Import substitution is planned to be promoted through increased incentives and encouragement for purchase of domestically produced machinery. In early 1977 the Government established a Committee for Machinery Localization Encouragement constituted of the heads of all relevant ministries and chaired by the Minister of E.P.B. Reporting to this committee are subcommittees at the Assistant Minister and Director levels. The Committee's policy proposals presented in March 1977 establish the principle of increasing localization in a number of machinery sub-sector, with specific reference to plant equipment. The proposals, to be developed further, outline basic strategy and related policy. Export would be encouraged through increased export credits and incentives. The machinery building industry sector is marked for intensive development at a total investmenmt outlay of US$1.85 billion during the 4th Five-Year Plan, excluding the allocation for shipbuilding and electronics.

13. In order to support intensive development of industrial sectors, Korea has established over 20 industrial estates around major population centers and ports. These are classified into four major groups: free export zones, special industrial estates, export industrial estates and local industrial estates. A large number of these are engaged in manufacturing in a single sub-sector such as electronics at Gumi, non-ferrous metals at Onsan and petro-chemicals at Ulsan. This approach lowers investment cost in infrastructure facilities, maximizes linkage and technology diffusion effects and reduces environmental pollution in the metropolitan centers. For the machinery industry, Korea has established an integrated machinery complex at Changwon.

KOREA: Prospective Supply and Demand in Machinery
(US$ millions, 1975 prices)

	1977	1978	1979	1980	1981
Requirement 1/	3,566	4,307	5,214	6,046	7,040
Production	2,128	2,628	3,246	4,010	4,952
Imports	1,438	1,679	1,968	2,036	2,088
Exports	522	704	918	1,158	1,415
Domestic Demand	3,044	3,603	4,296	4,887	5,625
Ratio 1/ of Imports (%)	40.3	40.0	37.7	33.7	29.7

Note: Shipbuilding and Electronic Products are excluded.

1/ Requirement = Production + Import; used as a basis to calculate import %.

Source: MCI; Korea Society for Advancement of Machine Industry.

The increase in exports represents an average annual growth of 32% and incorporates export of heavy manufatured goods. The relationship of these exports to total exports is shown in Table 3.

1. The Changwon Complex

14. Changwon has been conceived as a giant complex of 104 factories linked in the manufacture of machinery and parts. The physical layout of the Complex is shown in Map IBRD 12645 and the basic infrastructure discussed in Annex 4-8. The Complex covers a total area of 43.3 square kilometers, of which 17.4 square kilometers is allocated to industrial development, and incorporates all basic infrastructure requirements of the planned 100-plus facilities. The Complex was opened for construction of factories in 1974.

15. Along with the establishment of the physical infrastructure, the Government offered an attractive package of incentives to induce entry of both domestic and foreign enterprises in the area of machine manufacture. Some of the major incentives are shown in the following table.

KOREA: Incentives in Changwon Complex

	Domestic Enterprises		Foreign Enterprises	
	First 5 years	Next 3 years	First 5 years	Next 3 years
Taxes				
Corporate	Exempt	50%	Exempt	50%
Income	Exempt	50%	Exempt	50%
Property	-	-	Exempt	50%
Dividend	-	-	Exempt	50%
Business	Exempt for all firms engaged in export business			
Import Duties	Exempt on all capital goods and other imported for export purposes.			
Foreign Remittance			Profits and dividends guaranteed from first year, and principal from third year of operation.	
Financial Support	Loans at 12% interest repayable over 8 years with 3-year grace period available for 70% of land costs and 75% of facility costs; also 50% of operation funds provided at same interest, repayable over 3 years with no grace period.			

16. Since 1974, 49 factory units have entered the complex, including 9 joint venture enterprises. A complete list as of December 1976 is shown in Table 4. These divide along product lines as follows:

- 14 producers of metal products and components (the largest unit is a special steel plant).
- 20 makers of industrial machinery and equipment (this group includes Hyundai International and Samsung Heavy Industry; also eight machine tool factories).
- 3 makers of electrical equipment and appliances.
- 5 producers of auto parts.
- 7 producers in the miscellaneous category.

This development has fallen short of expectations in numbers of entrants and the types of factories, which are largely fragmented units engaged in relatively low capital-intensity operations. Duplication of capacity is also evident.

2. Project Relevance

17. The HII Project is the most significant constituent of the Changwon Complex and is expected to have a major impact on its future. The Project is Korea's first venture into the field of the manufacture of highly advanced and very heavy equipment and is designed to fill a substantial position of the domestic demand of such machinery in the steel, power and chemical/petrochemical industries. In the machinery sector report of the 4th Plan, turn-key plant export was singled out as a major new export opportunity for Korea. In this context, the Project is certainly not limited to import-substitution in the longer term. When the Project achieves full operation, it would supply large castings and forgings to other industries and it would be a buyer of a variety of equipment parts and subassemblies. In time, the forward and backward linkages can be expected to evolve into a cluster of large and small enterprises joined together in the manufacture of heavy plant equipment, sharing technologies, skills or some highly specialized and expensive pieces of production machinery. HII plans to facilitate this process by assisting in the strengthening of existing supply capabilities through help in product-selection, licensing and technology transfer and training.

3. Other Measures, Policies and Regulations

18. The development of the machinery building industry is further based on increased local-content in domestic plants, modernization of machinery-manufacturing facilities, availability of skilled manpower, technological advances, inducement of foreign capital and joint ventures, and export promotion.

19. The Government plans to limit the construction of domestic plants on a turn-key basis by foreign companies, promoting instead the development of local design and engineering firms and a high local content in all domestic plants. The investment outlay for the fourth Plan includes funds for the modernization of 500 existing small and medium-scale enterprises to strengthen the technological and production base. The country already has an excellent training program for basic technicians and machine operators and has planned further increases to meet the expected requirements of scientists, engineers and skilled manpower under the fourth Plan.

20. In regard to technological advances, the Government has developed a list of priority items for which incentives have been legislated. There is a tax reduction of eight percent on the proportion of undistributed profits used for investment expenditures in foreign technology (10% if domestic machinery is used), and a tax exemption on a reserve fund upto ten percent of profits. In the area of research and developments, to start with a new

metals and machinery institute at a cost of US$5 million has been planned for Changwon but not yet established. The overall investment in science and technology, excluding defense, has been stepped up significantly from the third Plan level of 0.3% of GNP to 1.0% of GNP or US$310 million between 1977-81. Research and Development is planned as a cooperative venture with the private sector sharing 60% of the cost burden.

21. Also, in order to encourage foreign investment, the Government promulgated the Foreign Capital Inducement Law in 1973. Under this law foreign enterprises that have been approved by the Economic Planning Board are permitted to import capital equipment, semi-finished products and raw materials on a duty-free basis. The law also includes the tax incentives discussed earlier in the context of Changwon. For domestic enterprises in priority industries such as the machinery industry the exemption on capital goods is applicable, but both customs duties and commodity taxes may be levied on import of materials and components. Investors have a choice between tax-holidays in early years, an 8% tax credit or a special 100% depreciation.

22. The machinery building industry (and the Project) is expected to be largely import-substituting. Flexible tariff protection has been granted in the past to some key import substituting industries. There has also been a tendency to impose procedural controls on competing imports of both intermediate and capital goods immediately following initiation of domestic production. In order to manage the prices of the products of industries that are monoplistic-oligopolistic in nature, the Government announces maximum prices for such products under the Price Stabilization Law revised in 1976. Generally, there has been a shift towards larger incentives to priority import-substituting industries, such as the machinery building industry. Export incentives such as reduction in taxes on earnings from exports, preferential credit and access to imports have been reduced as Korea's international competitiveness increased, but continue to favor exports over import-substitution.

23. In relation to financial assistance to the machinery building industry, a special fund was created in 1967 under the Machinery Industry Promotion Law. Subsequently, a number of special funds such as the National Investment Fund and a special fund for exports have been established. These funds are essentially intended to serve the needs of the machinery industry in two ways, in direct assistance to the manufacturer and in sales financing through loans to the end-user. Generally the terms for the funds to the manufaturer are 12-14% for 8 year loans and to the end-useer 12-14% for 5 year loans with some differences due to priority of the product-group and eligibility for different funds. The National Investment Fund is the largest element with approval of around US$376 million in 1976, of which US$75 million was channelled to the machinery industry. Total approval of US$443 million is planned for 1977. The special export import facility was established as an independent entity in 1970 with a subscribed capital of US$135 million. Loans of US$110 million primarily financed shipbuilding exports. The lending is proposed to be expanded to around US$400 million in 1977.

E. Sector Issues

24. The rapid growth of the sector and of the machinery industries has been remarkable. However, the heterogeneity of products and the primarily private ownership pattern has not permitted centralized planning as has been true for other sectors in Korea, such as power or steel. Consequently, certain weaknesses have developed in the sector. The Government is aware of these weaknesses and the development of a general strategy based on a number of studies in different areas, as under the Machinery Localization Encouragement Committee, is underway. However, detailed planning including allocation of responsibilities, implementation schedules and coordinating mechanisms still remains to be worked out. In order to ensure that the further planned growth of the sector occurs in an optimal manner, the following sector issues require further Government attention:

(i) Rationalization of Investment: As indicated earlier, centralized investment planning has not been possible in this sector and the Government concentrated on identification of priority products rather than projects. The HII Project is one of the very few exceptions. Considering the difficulties of centralized planning, it is important that mechanisms such as screening or monitoring agencies be set up to ensure that duplication of investment is avoided when approving new facilities.

(ii) Rational Development of Changwon: Progress to date in Changwon already shows fragmentation of capacities in small units and has fallen short of the intention of an integrated machinery complex. Consideration of existing facilities is important in planning future capacity in order to improve overall efficiency of the Complex. Such planning and control requires immediate Government attention.

(iii) Transfer of Technology: In this area, there is again the need for rational acquisition of relevant and up-to-date technology, without duplication of licensing arrangements. Larger companies, such as HII, have the resources to suitably select such technology and should be encouraged to assist smaller producers in obtaining adequate licensing arrangements. In this regard, the responsibility for monitoring progress and screening proposed agreements on this basis should also be clearly allocated to existing or new agencies.

(iv) Research and Development: The adequacy of research and development support is critical to the development of the machinery industry especially in technologically advanced areas. Quality assurance is key not only for the producers but also for their suppliers. The fund allocation of US$5 million for the research institute at Changwon would not be adequate to provide such support. The Korea Institute of Science and Technology has a precision machinery center and a foundry center but neither has the physical facilities to undertake the range of development work required by the emerging heavy

industries. There is a need to accumulate existing knowledge in the country and facilitate its dispersion to smaller producers; a systematic assimilation of new knowledge should proceed simultaneously.

(v) Upgrading of Training: Korea has an excellent training program, which has proved adequate in the past. However, as the orientation of the machinery industry changes towards high technology heavy manufacture, an upgrading in the skills of the training graduates would be required. Various studies exist on upgrading of training programs, to include modern production techniques, exist but a comprehensive program is yet to be developed.

(vi) Development of Supply Industries: The fourth Plan provides for funds for the modernization of small and medium-scale enterprises, but rational plans for such assistance are only now being developed. The total investment allocation of around US$1.85 billion for the fourth Plan might not prove adequate. It is important that planning for these, the supply industries, take place alongside that for the heavy industries. This is needed to ensure the availability of an adequate domestic source of materials and components and the establishment of appropriate backward linkages.

(vii) Sales Financing: Mechanisms already exist, as indicated, to assist sales of machinery products. However, again, the amounts allocated would not suffice to support the sales of the heavy industries. The sales from the Project alone are expected to be around US$400 million (in constant 1976 terms) at full operating, against the National Investment Fund 1976 machinery industry loans of US$75 million. Availability of sales financing is likely to be one of the critical factors in the success of the Project and other ventures in this sector.

(viii) Export Strategy: The Government is already taking steps to establish export-promotion funds and should review the needs of the heavy sector in determining the amounts. In addition, planning should focus on product-mix selection for export and on additional promotion measures to support the priority products in realizing early export potential.

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KOREA

HEAVY MACHINERY PROJECT

OTHER HEAVY MACHINERY AND EQUIPMENT MAKERS IN KOREA

Company	Location	No. of Employees	Major Products	Remarks
Daewoo Heavy Industries	Inchon	3,500	Railroad equipment, forklift, diesel engine	Formerly Hankook Machinery Works; acquired by Daewoo, a major textile producer, in 1976
Korea Heavy Machinery	Seoul and Changwon	1,700	Railroad equipment industrial machinery machine tools	New machine tool plant in Changwon began operation in mid-1976
Kangwon Industrial Company	Pohang	2,000	Mining machinery, steel castings, steel plant parts	Plant also produces steel
Daehan Chemical Machinery	Inchon	630	Chemical equipment	
Daehan Boiler	Seoul	170	Industrial boilers and pressure vessels	
National Chemical Machinery	Pusan	200	Chemical equipment	
Echun Heavy Machinery	Seoul	300	Paper plant machinery, steel fabrication, rolls	
Samsung Heavy Industry	Changwon	1,000	Plant equipment	New plant to be built at Changwon in collaboration with IHI of Japan 1st stage = $34 million
Hyundai International	Gunpo	1,900	Plant equipment, construction machinery	Manpower expected to double by 1979, as Gunpo reaches full capacity

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Table 1

KOREA

HEAVY MACHINERY PROJECT

GROWTH OF VALUE ADDED IN MANUFACTURING - 4TH PLAN

(billion won in 1975 prices)

	1975 Value Added	%	1981 Value Added	%	Rate Needed to Achieve Target
Manufacturing	2536.4	100.0	5460.0	100.0	13.6
Heavy & Chemical Industries	1084.3	42.8	2809.0	51.5	17.2
Metal Industries	111.5	4.4	304.5	5.5	18.2
Iron & Steel	96.7	3.8	243.5	4.5	
Non-ferrous Metal	14.8	0.6	61.0	1.0	
Machinery Industries	334.2	13.2	1153.0	21.2	22.9
Machinery	181.0	7.1	622.1	11.4	
Electronics	121.2	4.8	420.5	7.7	
Shipbuilding	32.0	1.3	110.4	2.0	
Chemical Industries	838.6	25.2	1351.5	24.8	13.3
Oil Rifining	265.2	10.5	442.3	8.1	
Petrochemicals	50.8	2.0	205.5	3.8	
Fertilizer	44.6	1.8	82.5	1.5	
Other Chemicals	279.3	10.9	621.2	11.4	
Light Industries	1452.1	57.2	2651.0	48.5	10.6
Textile & Textile Products	571.9	22.5	1130.0	20.6	12.0
Others	880.2	34.7	1521.0	27.9	9.5

Source: EPB

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ANNEX 3-1
Table 2

ANNEX 3-1
Table 3

KOREA

HEAVY MACHINERY PROJECT

COMMODITY EXPORTS

(In Billion 1975 Dollars)

	1975		1981	
	Amount	Share	Amount	Share
Total Export	5.08	100	13.0	100
Primary Products	0.77	15	1.13	9
Manufactures	4.31	85	11.87	91
Light Industry Products	2.82	56	5.65	43
Heavy Industry Products	1.49	29	6.22	48
Selected Sector :				
Machinery Industry 1/	0.29	6	1.42	11

Source: Economic Planning Board, Fourth Five-Year Plan

1/ Excludes shipbuilding and electronics

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KOREA

HEAVY MACHINERY PROJECT

STATUS OF PROJECTS IN CHANGWON COMPLEX, AS OF DECEMBER 1976

Company	Total Investment (Million Dollars)	Technical Collaboration	Major Products	Remarks
1. Changwon Industry	3.0	Joint Venture with Japan	Forgings and dies	Operation started in 1975
2. Namyung Metals	2.2	Joint venture with Japan	Castings	"
3. Korea Special Steel	107.2	Collaboration with US, Spain and Japan	Special Steels	Under Construction
4. Mijin Metals	2 9	-	Castings and forgings	"
5. Pusan Steel	12.8	-	Castings and forgings	"
6. Hanil Forgings	2.6	-	Forgings	"
7. Pusan Valve	5.0	-	Valves	Operation started in 1974
8. Tongkwang Steel	3.4	Joint venture with Japan	Bolts and nuts, shaft	Operation started in 1976
9. Tongmyung Enterprise	8.3	Collaboration with Germany and Japan	Hydraulic machinery	"
10. Tongyang Machinery	32.7	Collaboration with Japan and England	Gear machinery	"
11. Sin-A Fastener	2.4	Collaboration with US	Bolts and nuts	"
12. Hankook Bearing	11.2	Collaboration with Japan	Bearings	Under Construction
13. Korea Heavy Machinery	27.0	Collaboration with Japan	Machine tools	Operation started in 1976
14. Kukje Machinery	22.1	-	Small machine tools	"
15. Tong-Il Enterprise	5.5	-	Gen. purpose machine tools	"
16. Daewoo Heavy Industry	10.7	-	Machine tools	Under Construction
17. Che-Il Precision Machinery	8.8	-	Small machine tools	"
18. Che-Il Machinery	6.8	-	Gen. purpose machine tools	"
19. Jin-Il Industry	15.4	Collaboration with Denmark	Engines	"
20. Miwon Machinery	7.2	-	Chemical equipment	"
21. Daehan Chemical	25.8	Joint Venture with Japan	Chemical equipment	"
22. Tongyang Enterprise	10.2	-	Agricultural machinery	"
23. Sam Hwa Machinery	2.0	Collaboration with Japan	Gas compressor	"
24. Tae Hwa Rubber	15.3	-	Small tools	At planning stage
25. Daedong Machinery	10.0	-	Press, castings	"
26. Korea Shipbuilding	15.6	Collaboration with Japan	Marine machinery	"
27. Hyundai Shipbuilding	138.1	-	Marine machinery	"
28. Hankook Machine Tool	2.5	-	Machine tools (lathes)	"
29. Tongyang Special Machinery	1.3	-	Pulp and paper machine	"
30. Hyundai International	390.9	-	Plant equipment	"
31. Samsung Heavy Industry	34.0	-	Plant equipment	"
32. Hwachun Machinery	12.9	-	Gen. purpose machine tools	"
33. Daehau Optical Equipment	3.9	Collaboration with Japan	Binoculars, camera	"
34. Tongyang Heavy Electrical	8.7	Collaboration with Japan	Transformer, circuit breaker	Operation started in 1975
35. Gold Star Co.	17.9	Collaboration with Japan	Household appliances	Operation started in 1976
36. Hanyung Industry	25.3	-	Heavy electrical equipment	Under Construction
37. Samsung Radiator	3.7	-	Auto radiator	Operation started in 1976
38. Kia Enterprise	12.6	Collaboration with Japan	Chain	Under Construction
39. Hankook Carburator	3.8	-	Carburetor	"
40. Poongsung Precision Machinery	2.3	Joint venture with Japan	Auto instruments and gauges	"
41. Changwon Carburetor	2.0	-	Carburetor	"
42. Jinhae Battery	3.3	-	Storage battery	Operation started in 1975
43. Union Gas	13.0	Joint venture with US	Liquid oxygen	Under Construction
44. Hankook C.A.V.	10.0	Joint venture with UK	Fuel injector	At planning stage
45. Poonysaeng Metal	2.0	-	Heat treatment	Under Construction
46. Samchun Chemical	2.0	-	Surface treatment	"
47. Tonghae Enterprise	1.0	-	Heat treatment	At planning stage
48. Kangwon Industry	26.5	-	Boiler, seamless pipe	Status of project uncertain
49. Daewon Steel	4.5	-	Spring	"

Source: Changwon Industrial Complex Development Cooporation, Korea

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ANNEX 3-1
Table 4

KOREA

HEAVY MACHINERY PROJECT

MARKET FOR THE PROJECT

A. Introduction

1. The Korean economy has grown rapidly in the past decade registering GNP growth rates of 10.5% in the second Plan (1967-71) and 9.4% in the third Plan (1975-76). The growth in the manufacturing sector has significantly outpaced overall growth. The sector has grown at an average rate of 18.4% since 1971 and is expected to grow at a rate of 13.3% in the fourth Five-Year Plan (1977-81). The fourth Plan places special emphasis on the development of heavy and chemical industries which are planned to grow at an average rate of 16.8%. Under the fourth Plan the Government aims to build domestic capability in the manufacture of plant-equipment to support such growth. In view of this objective, the Government has selected HII to set up a modern facility for the manufacture of plant equipment under the Project. The Project will be the first facility in Korea planned for the manufacture of the very heavy class of plant equipment, and will contribute towards the objective of import-substitution.

2. Within the heavy and chemical industries, the steel sector has been growing most rapidly at a rate of 36.8% since 1971 and contributed around 4.5% of the manufacturing output in 1976. The chemical industries sector contributed nearly 25% of the total manufacturing output showing a growth rate of 17.2% since 1971. These two sectors are expected to continue rapid growth under the 4th Plan (17.9% and 13.2% growth respectively) and together with the power-generation sector, which is planned to keep pace with the development of the economy, are the primary target markets for the project:

(i) Steel Sector: Pohang Iron and Steel Co. (POSCO), a government enterprise, has a present capacity of 2.6 million tons of crude steel per year to be expanded to 5.5 million tons by mid-1979. The project is planned to supply equipment for the subsequent expansion to 8.5 million tons scheduled to be implemented in 1979-1982. In addition it is expected to supply equipment for rolling and finishing capacity expected to be installed by smaller private companies. Beyond 1982, the Project would meet the demands of further expansions in steel production capacity;

(ii) Power Generation Sector: The power network in Korea is operated by the government-owned Korea Electric Co. (KECO). Over the fourth and fifth Five-Year Plans (1977-86), KECO plans an ambitious program of expansion of generating capacity as well as modernization and standardization of its system. The plans call for thermal plants (300-500 MW), hydroelectric plants (50-400 MW), pumped storage plants

(300-400 MW) and nuclear power plants (600-900 MW). The Project is designed to undertake the integrated manufacture of all power plant equipment and would initially concentrate on conventional thermal power stations and also service the requirements for hydrostations to come on stream in Korea from 1980 onward. With experience, the Company would be in an excellent position to undertake nuclear equipment manufacture.

(iii) Chemical/Petrochemical Sector: Korea's petrochemical industry has developed rapidly since 1970 with the establishment of the country's first petrochemical complex at Ulsan and produces a variety of intermediate and end-products in plastics, fibers and elastomers. Future growth is importantly linked to the growing exports of textiles and garments. The fourth Five Year Plan calls for expansion of the Ulsan complex and the establishment of a new complex at Yeochun. The Project is intended to supply equipment for these and future programs (fifth Five-Year Plan) in the sector. The equipment for the sector primarily comprises fabricated items, an area in which the country and the Hyundai Group have some related experience. Supported by the marketing organization and the past record of the Group companies in overseas construction, HII could achieve early success in the turnkey export of chemical/petrochemical plants.

3. In the following sections, the three major consuming sectors will be examined in detail to determine the appropriateness of the Project's planned production program. Further, the demand and market for plant equipment will be determined to establish the viability of the levels of production during start-up and full operation. Potential for export and sales to the domestic replacement market has not been considered in the analysis.

B. The Steel Sector

1. Demand

4. The following table shows the historical consumption and supply of steel in Korea. The increase in domestic consumption has been led by the investment in construction activity as Government efforts focussed on the building of infrastructure - land development, roads, highways, ports and harbor projects.

KOREA: Steel Demand and Supply

(Finished Steel - 000 Metric Tons)

	1967	1969	1971	1973	1975	1976 (est.)	Growth Rate 71-76
Total Requirements 1/	755	1,317	1,771	3,292	3,289	4,280	19%
Apparent Consumption	743	1,285	1,570	2,431	2,188	2,995	14%
Export	12	42	201	861	1,101	1,285	45%
Production	470	1,010	1,461	2,829	2,609	2,680	13%
Import	285	317	310	463	680	1,600	39%
Percent Total Requirements Imported	37.7	23.9	17.5	14.1	20.7	37.4	
Percent Total Requirements Exported 2/	1.6	3.2	11.3	26.2	33.5	30.0	

Source: 1967-1973, POSCO
1975 and 1976, EPB

1/ Total Requirement = Apparent Consumption + Export = Production + Import

2/ Percent export is given on basis of total requirement (Production plus Import) rather than production alone because some export tonnage is derived from imports e.g. imported hot-rolled coil is exported as cold-rolled coil or sheet.

5. Steel demand in Korea can be expected to increase steadily as the country's development continues, especially in the heavy and chemical industries, planned to grow at an overall rate of around 18% between 1977-81. The following table shows the demand projections from two sources:

(i) Korea Development Institute (KDI) projection is derived from its macro-economic model and is based upon a projected GNP growth at 9% annual rate and an export rate continuing at 30% of total requirements.

(ii) U.S. Steel projection is derived from a macro as well as micro analysis of the major steel user industries and based

upon a GNP growth of 10% annual rate and export of 30% of total demand. Steel demand is projected to grow at 22% annually through 1980 and at a slower rate of 12% annually thereafter as the steel intensity increases and the growth curve levels off.

KOREA: Finished Steel Demand Projections
(000 metric tons)

	1976	1981		1986	
Finished Steel	(Estimate)	KDI	USS	KDI	USS
Apparent Demand	2,995	6,575	7,350	11,270	12,000
Export	1,285	2,990	3,200	5,220	5,400
Total Requirement	4,280	9,565	10,550	16,490	17,400
Total Requirement in crude steel (at 80% yield)	5,350	11,950	13,200	20,600	22,000

Finished Steel Growth/GNP Growth (KDI forecast) 1976-81 : 1.44
1981-86 : 1.12

6. Of the two forecasts, the KDI forecast more closely reflects the present GNP growth target of 9.0% in the fourth Plan and is probably more realistic. The forecast implies a domestic demand growth of 17% between 1976-81 (vs. 19%, 1971-76) and 11% between 1981-86. The 1981 projection translates to a per capita steel consumption of 300 kg which seems reasonable in comparison with Japan's performance in the past (260 kg, 1960-64) or that of Spain (315 kg, 1973).

7. The export of steel is more difficult to assess in view of the dynamics and complexity of the international steel market. The 30% export assumed in both projections is optimistic and based upon the recent performance of the steel industry (45% annual export growth, 1971-76), as well as upon the expectation that the low labor and overhead cost structure of the industry would enable it to continue to compete successfully. However, conditions could change and curtail the level of exports. It might be noted that in the past, performance has tended to exceed projections for both the second and the third-Five-Year Plan periods. In view of these factors, the demand estimate of 11.0-12.0 million tons in 1981 and around 18.0-20.0 million tons in 1986 is considered reasonable.

2. Supply

8. POSCO today has a capacity of 2.6 million tons per year of crude steel. The third expansion of POSCO, to be completed in early 1979, will

increase it to 5.5 million tons. The fourth expansion, planning for which is already underway, will further raise it to 8.5 million tons. In addition, there are 14 private steel producers with a combined capacity of about 2 million crude steel tons; these plants produce steel by melting scrap in the electric furnace (Table 1). In 1976, these mini-plants accounted for over 35% of the total production of 3.34 million tons of crude steel.

9. Future supply must consider not only the tonnage increase in demand but also the change in the composition of demand. Through about early 1970, well over 50% of the demand originated in the construction sector. This will no doubt change. During the fourth Plan and beyond, with increased developmental emphasis on the manufacturing sector, the demand for flat products and for higher quality engineering steels can be expected to increase more rapidly relative to the demands from the other sectors. This would suggest that there will be a practical limit to the self-sufficiency rate that Korea can hope to achieve, since the steel industry will still be small in 1986 by world standards and cannot be expected to produce the variety of steels that the home market will require.

10. The fourth Five-Year Plan objective of the Government for the steel sector is an increase in the self-sufficiency ratio of steel upto 78%. However, only two investments in capacity have been identified - POSCO expansion from 5.5 million to 8.5 million tons by 1982 (Table 2) and the establishment of the special steel plant with an output of 250,000 tons of alloy and stainless steels by the middle of 1978. No final plans have yet been established beyond that, but it is expected that the Government would seek to reach the fourth Plan objective of high self-sufficiency. In view of the 18.0-20.0 million ton requirement in 1986, an expansion of capacity upto at least 15.5 million tons is considered reasonable. This probable pattern of capacity installation is shown below.

KOREA: Steel Capacity and Production
(million tons crude steel)

Year	Total Requirement	Capacity			Production			Self-Sufficiency Rate (%)
		Total	POSCO	Other	Total	POSCO	Other	
1976	5.35	4.5	2.6	1.9	3.34	2.15	1.20	62
1981	11.0-12.0	8.7	5.5	3.0	7.6	5.0	2.6	63-69
1986	18.0-20.0	15.5	8.5	7.0	13.5	7.5	6.0	67-75
Added Capacity		1976-81 : POSCO 2.9; Others 1.1						
		1981-86 : POSCO /1 3.0; Others 4.0						

/1 Investment largely in 4th Plan period 1979-81.

11. The large expansion under "others" in 1981-86 reflects the fact that no further expansion is possible at the POSCO site, and is likely to be primarily achieved through a second integrated steel mill. Plans for such a mill of 3.5 million ton crude capacity were earlier drawn up and then deferred past 1981. The remainder would be made up by expansion of the smaller electric furnace installations. With more steel available for processing, the private steel plants would also be able to significantly expand their finishing capacity. The capacity expansion in crude steel between 1977-86 would require addition to this capacity of around 4.0 million tons to maintain the balance between crude and finished production. The historical and projected investment in this sector is shown below.

KOREA: Investment in Steel Sector
(US$ millions)

Facility		Actual Investment	Facility	Projected Investment
POSCO	1st Stage (71-73)	283	POSCO 4th Stage (79-82)	1,286
	2nd Stage (74-76)	546		
Others	(72-76)	133	Others (77-81)	450
POSCO/1	3rd Stage (76-79)	1,355	2nd Mill (82-86)	1,526
Kisco	(75-77)	71	Others (82-86)	650
Total Committed 1971-76		2,388	Total 1977-86	3,912
Estimated Investment 3rd Plan		1,288	4th & 5th Plans	4,912

/1 Construction well underway and therefore unavailable to the Project.

C. Power-Sector

1. Demand

12. Consumption of electric power in Korea has increased at dramatic annual rates in the past, averaging over 20% through 1973.

KOREA: Actual Power Sales (GWh)

	Lighting	Small Power	Large Power	Agri-culture	Total Sales
1967	572	1,106	2,190	35	3,903
1970	1,009	1,824	4,870	37	7,740
1973	1,738	2,851	7,222	56	12,367
1974	1,853	-	12,136 1/	59	14,048
1975	2,130	3,420	10,996	84	16,630
1976(Est.)	2,500	4,000	13,000	100	19,600
Growth Rate					
1967-73	20.3%	17.1%	22.0%	8.2%	21.9%
1973-74	6.6%	20.4%	20.4%	5.3%	13.6%
1974-75	14.9%	18.8%	18.8%	42.4%	18.4%

Source: Ministry of Construction and Industry

1/ Includes also small power, with growth rates for 73 - 74 and 74-75 derived on a combined basis for small and large power.

The overall growth rate was comparatively low from 1973 to 1974, but showed a marked increase again in 1975, as the economy recovered from adverse effects felt in 1974.

13. Demand in the future is expected to continue growing rapidly, though at a somewhat slower pace. Load forecasts by KECO call for increase in sales to 38,960 GWH in 1981 (14.7% average increase in the fourth Plan), and to 69,270 GHW in 1986 (12.2% increase in the Fifth Plan). The forecast (Table 3) is based on the assumption of a maturing economy resulting in lower elasticity coefficients as shown below:

KOREA: Power Load Forecast Assumptions

	3rd Plan	Forecast	
		4th Plan	5th Plan
	71-76 (Est.)	77-81	82-86
GNP	9.4	9.2	9.0
Mining and Manufacturing	17.6	14.2	12.6
Total Energy Sales	17.1	14.7	12.2
Lighting	15.2	13.3	12.4
Small Power	14.1	13.5	11.5
Large Power	18.6	15.3	12.4
Agriculture	21.1	14.9	8.4
Aggregate Elasticity (Energy Sales/GNP)	1.82	1.60	1.36

Source: KECO Long Range Development Plan

14. The Bank power sector mission in 1974 projected lower sales figures, based upon an expected GNP growth rate of 8% in the fourth Five-Year Plan, in light of the then depressed economy in Korea. However, recent performance of the economy suggests that the KECO forecast based on higher GNP growth rates is reasonable.

2. Generation

15. Based on the KECO forecast for demand, the peak demand requirements are presented in Table 3, assuming improved transmission and distribution efficiency. Accordingly, KECO has drawn up the following schedule of buildup of capacity. Significantly, the ratio of dependable capacity to installed capacity in 1975 is estimated by KECO at a low 76%, yielding an effective reserve margin of dependable capacity to peak demand of less than 8%. The reasons given for the low ratio are frequent equipment breakdowns, and problems in spare parts supply. The buildup schedule proposes to raise the reserve margin to around 20%.

KOREA: Projection of Power Supply and Capacity

Year	Peak Demand (MW)	Installed Capacity (MW)	Dependable Capacity (MW)	Reserve 1/ MW	Reserve 1/ %
1975 (Actual)	3,351	4,720	3,612	261	7.8
1976 (Actual)	3,807	4,810	3,954	147	3.9
1977	4,584	6,540	4,739	251	5.6
1978	5,315	7,217	6,218	903	17.0
1979	5,973	8,117	7,157	1,184	19.8
1980	6,760	9,227	8,216	1,456	21.5
1981	7,606	10,427	9,616	2,010	26.4
1986	13,375	18,887	16,207	2,610	19.5

Source: KECO Long Range Development Plan

1/ Dependable Capacity less Peak Demand

16. The historical growth in power-generation capacity between 1972-76 is shown below. During this period the bulk of the investment went into thermal power with the ratio of thermal to total power increasing from 67% to 86%.

KOREA: Installed Capacity (MW)

	1st Plan		2nd Plan		3rd Plan	
	1962	1966	1967	1971	1972	1976
Thermal	290.6	554.0	616.8	2,286.8	3,529.7	4,099.0
Hydro	143.5	215.5	300.5	341.3	341.3	711.0
Total	434.1	769.5	917.3	2,628.1	3,870.8	4,810.0

Future plans call for greater diversification of power resources through installation of nuclear plants, tidal plants and large pumped storage units to meet peaking requirements, with the dependence on thermal plants falling to around 80% by 1981 and below 65% by 1986.

17. The projected pattern of installation of capacity is based on the schedule of new plants shown in Table 4. The schedule reflects the policy of size standardization. Beyond the new thermal plant number 3, KECO plans to install exclusively plants of 500 MW capacity. The plan is considered adequate in view of the projected demand, losses and required reserve margins. The total investment in the next decade is shown in the following table in relation to the historical pattern. In mid-76 terms, the planned investment in this period amounts to US$7.7 billion. The low figure for 1982-86 reflects exclusion of investment in 1983-86 for plants to come on-stream after 1986.

KOREA: Investment in Power Generation

	1967-71	1972-76	1977-81	1982-86
Investment in Installed Capacity (MW)	1,860	2,180	5,620	8,460
Investment /1 in Power Plant (US$ Mils)	481	799	3,160	3,320

1977-86 Investment (mid-76 prices)

Thermal Plants	(22)	3,105.6
Nuclear Plants	(5)	3,805.0
Large Hydro Plants	(4)	862.1
Total		7,772.7

Source: KECO

/1 For 1967-76 in current prices, thereafter in constant 1975 prices.

D. Chemical/Petrochemical

18. Korea's chemical sector began to develop as a modern industry in the mid-60s, prior to which production was limited to final products such as paints, detergents, caustic soda, sulphuric acid and medicine. Beginning with the establishment of an oil refinery and two urea plants under the first Five Year Plan (1962-66), production activities have accelerated rapidly along with demand. Significantly, under the second and third Plans (1967-76), the chemical industry received significant planning emphasis and a major petrochemical complex was established at Ulsan. While the industry is not large, its special significance to Korea derives from its linkage to the export-oriented textile and garment industries.

1. Demand

19. Domestic consumption of petroleum and petrochemical products has grown rapidly over the past decade. The demand for fuels increased from 1.8 million tons in 1966 to about 10.6 million tons in 1974 at an average annual rate of 25%. Exports (principally subcontracting and balancing of refinery output) have increased at about 21% from 350,000 tons in 1966 to 1.7 million tons in 1974. The requirements of feedstocks for the petrochemical industry have averaged an increase of around 35% over this period.

20. The consumption record for the major petrochemicals between 1968 and 1974 is shown in Table 5 and confirms a growth rate of 35%. Demand is projected to continue growing led by increasing exports in textile and garments. The projections under the Fourth Plan call for a 9.6% growth in

petroleum and growth rates averaging around 20% for major petrochemical products. Firm long range forecasts for the Fifth Plan are not yet available, though growth is tentatively projected to slow down to around 10% in this period. Detailed forecasts are shown in Table 6.

21. The chemical pulp sector is also targetted for supply under the Project. Since 1970 pulp consumption in Korea has been increasing at an average rate of 10.6%, with the demand for chemical pulp increasing at around 13% as shown below; this higher rate for chemical pulp reflects the trend towards higher quality paper production.

Production & Import of Pulp (000 Tons)

	1960	1965	1970	1972	1974	Growth Rate 70-74
Production	13.4	28.9	80.2	84.3	96.8	4.8
Import	26.1	59.1	170.0	225.2	276.7	12.9
Apparent Consumption	39.5	88.0	250.2	209.5	373.5	10.6
Of which Chemical Pulp Consumption	19.5	57.3	160.3	226.2	261.4	13.0

Demand is expected to increase at a slower rate of 10.8% over the fourth Five-Year Plan rising to around 600,000 tons by 1981.

2. Supply

22. As shown in Table 5 and the table above, a large percentage of the demand for petrochemicals and for chemical pulp has been historically met through imports. The current refining capacity in the country amounts to 435,000 barrels per stream day (BPSD) and petrochemical facilities are designed around a 100,000 ton per year naptha cracker. The existing plants are shown in Table 7. So far demand requirements and refinery yields have been balanced such that from crude imports the country is able to almost fully satisfy its fuel product requirements. Under the fourth Plan, the Government proposes to continue this policy with refinery capacity projected to rise to 675,000 BPSD in 1981, and 1,050,000 BPSD in 1981.

23. At the petrochemical product end, the Government proposes to significantly curtail dependence on imports by expanding the Ulsan Complex and building another complex at Yeochun. The core of the program is an expansion of the naphtha cracker at Ulsan by 50,000 tons per year and the

building of a new cracker at Yeochun of 350,000 tons per year capacity. The program represents a scaling down from an earlier plan to build two new 350,000 ton crackers. A number of downstream plants are also planned. In addition, a chemical pulp plant of 300 ton/day capacity (US$91 million) and other investments in the area of fine chemicals and facilities such as an ion exchange salt plant (US$300 million) are also scheduled. A list of the major new plants is shown in Table 8 amounting to a total investment in the sector of around US$1.9 billion through 1981.

24. Under the fifth Plan, the projections call for further increase in capacity to meet domestic demand. Tentative estimates based on fourth Plan indications are shown in Table 9 and amount to a total investment of around US$2.5 billion. In summary the supply situation in the sector is planned to shift from reliance on imports to a high degree of self-sufficiency in petrochemical products. The investment in the next decade is summarized below, and compares reasonably with investment undertaken in the 3rd Plan.

KOREA: Petrochemical/Chemical Investments 1977-86
(US$ millions)

	3rd Plan	4th Plan	5th Plan
Refining Capacity	150.3	332.6	525.0
Petrochemical Plants	309.3	884.7	954.0
Pulp Plant	363.1	91.2	279.0
Other Chemicals	412.8	580.0	800.0
	1,235.5	1,888.5	2,558.0

E. Plant Equipment Market for the Project

1. General Considerations

25. The domestic plant equipment market generated from the investment plans outlined above will form the primary market for the Project. The Project design incorporates sufficient flexibility to enable manufacture of plant equipment and heavy machinery for other sectors also. The primary market can therefore be expanded through additional licensing arrangements as need develops. The analysis herein concerns itself with sales of new plant equipment; sales of ancilliaries and jobbing products to sustain the production capacity would be in a number of different areas and have not been covered. The analysis also excludes any consideration of possible exports which would potentially provide a safety margin over and above the domestic sales.

26. The market comprises a number of complex products in each sector and is difficult to assess in terms of physical units. The assessment is based instead in terms of mid-1976 constant dollars. The value is derived from the total investment program on a percentage equipment basis. The percentages used reflect past experience of domestic buyers and of HII licensors. The equipment accounted for in these percentages relates only to products to be manufactured by HII and excludes items such as structural steels, general pipes, valves and fitting which could be supplied by other domestic manufacturers. In the range of equipment covered, HII is expected to be the sole domestic supplier for the time being with some local subcontracting arrangements. No final plans for any other facility to undertake manufacture of similar equipment currently exist in the country and accordingly HII is not expected to be faced with any domestic competition in the near future.

2. Steel-making Equipment

27. The equipment market deriving from the steel sector investment program comprises the full range of iron-making, steel-making and rolling/finishing equipment. Under the 4th Plan, HII's primary target would be POSCO's 4th Expansion:

KOREA: Steel-Equipment Market (4th Plan)

POSCO 4th Expansion (1977-81)

			US$ millions
Crude Steel Capacity (million tons) 3.0			
Investment (US$ million)	1,286 1/	Equipment: Iron-Making	185
		Steel-making	139
		Rolling/Finishing	200
		Others	53
		Total	577
Other Investment (1.1 million tons)	450	Equipment	250

Equipment Market	1978	1979	1980	1981	Total
Value (US$ millions)	108	194	252	223	777
HII Sales (US$ millions)	5.8	29	40	48	122.8
HII Market Share	5%	15%	16%	22%	16%

1/ The investment cost of US$427 ton of crude steel capacity is very conservation in view of experience in other countries but is based on POSCO's actual experience to date, adjusted for inflation to mid-1976 levels. It takes account of cost data from the third expansion currently underway.

Since POSCO is a government enterprise and HII would be the only company in Korea capable of supplying the equipment, the probability of HII securing the POSCO contract, jointly with their licensors is very high. The sales breakdown by year, amounting to a share of only 22% in 1981 is considered attainable in view of HII's build-up of capacity and capability.

28. Under the fifth Plan, the estimates of the equipment market are shown below:

KOREA: Steel-Equipment Market[1/] (5th Plan, 1982-86)

Program		2nd Mill	Others
Crude Steel Capacity (million tons)		3.5	0.5
Invesment (US$ million)		1,526	250
Finishing Capacity (US$ million)		-	4.0
Investment (US$ million)		-	400
Total Investment (US$ million)		1,526	650
Equipment:	Iron-making	213)	75
	Steel-making	130)	225
	Rolling/Finishing	280)	15
		685	315

Equipment Market	1982	1983 onward
Value (US$ million)	200	200
HII Sales	66	76.9
HII Market Share	33%	38%

1/ Estimate based on a second integrated steel mill of 3.5 million tons and 4.0 million tons of additional rolling/finishing capacity. Costs based on earlier plans for 2nd Steel Mill and adjusted POSCO data. In order to capture a larger market share than shown for 1983, the Company would have to make additional investments to increase production capacity.

3. Power Generation Equipment

29. The power-generation equipment market resulting from KECO's expansion program, after the Project begins production in 1978, is shown in Table 10 and summarized below. The market is based on existing plans, which only include plants to be completed within the fourth and fifth Five-Year Plans. As planning beyond 1986 is undertaken, the market in the period 1983-86 can be expected to be increased further in light of plants scheduled to be completed in 1987 and beyond. Additionally, equipment sales for replacement purposes estimated at US$12 million in 1975, which can be expected to increase significantly as the installed capacity increases would further increase the power plant equipment market available to HII. This market is the most important market for HII in view of its continuity and its large size relative to the other two sectors.

KOREA: Power-Generation Investment /1
(US$ Millions)

	Actual			Projected	
	1974	1975	1976	1977-1981	1982-1986
Investment	171	256	249	3,790	3,980
Machinery Investment %	65	65	65	68	65
Primary Equipment %	55	55	55	59	56
Primary Equipment Market	94	141	137	2,236	2,228
Market Available to Project				1,100	2,228
HII Sales	-	-	-	342	780.4
HII Market Share	-	-	-	32%	35%

Source: KECO

/1 Machinery Investment and Primary Equipment % are estimated based on the mix of plants. It is higher in the projections due to inclusion of nuclear plants.

30. In the early years, HII plans to concentrate on the thermal plant market in collaboration with its licensor, General Electric. The companies are already jointly engaged in presenting plans for Thermal Plants 3 and 4 to KECO and the various ministries. HII has already signed a license for hydroturbines with Creussot-Loire, for hydro-generators with Alsthom-Atlantique and the license with General Electric includes the possibility of nuclear turbines. With experience, the Company plans to move into these fields. The Company's market position is significantly strengthened through its relationship with General Electric. Of the full range of boiler, turbine, generator, condenser and feed-water equipment for this sector, HII only plans to manufacture the less complex products at startup, reflected in the fact that in-house manufacture is only 49% of the sales value in 1978 (see Annex 7-1). The projections for sales are considered attainable in light of these factors.

Chemical/Petrochemical Equipment

31. The market for this sector comprises mainly fabricated equipment; reactors; heat exchangers; vessels and tanks; columns and towers; and process machinery including pumps and compressors. Together these constitute around 35% of the total investment program in this sector in Korea as shown below:

KOREA: Chemical/Petrochemical Equipment Market
(US$ millions)

		4th Plan Cost %	4th Plan 1977-81	5th Plan 1982-86
Investment		100	1,888	2,558
Equipment:	Reactors	4.5	85	115
	Heat Exchangers	9.0	170	230
	Vessels and Tanks	3.8	72	95
	Columns and Towers	5.2	98	135
	Process Machinery (includes pumps and compressors)	12.8	245	325
	Total	35.3	670	900
	HII Sales		114	400
	HII Market Share		17%	44%

32. The low aggregate market share in the 4th Plan period takes into account the fact that a major portion of the planned investment is scheduled to take place in 1977-79 and thus would not be available to the Project. However, there has already been some slippage in implementation, thus improving market availability to the Project. The market forecast by year is shown below.

KOREA: Available Chemical/Petrochemical Equipment Market (1978-83)
(US$ millions)

	1977	1978	1979	1980	1981	1982	1983 onward
Total Equipment Market	100	140	150	140	140	180	180
Available to Project	-	60	110	140	140	180	180
HII Sales		4	25	25	60	80	80
HII Market share		7%	23%	18%	43%	44%	44%

33. HII's position in this sector is strengthened by the fact of the significant fabrication-related experience currently available in the Hyundai Group. HII itself, supported by its construction affiliate is already engaged in marketing cement plant overseas. The same approach could prove very successful in marketing chemical plants abroad in the longer term. However, as mentioned previously the export potential has not been considered in this analysis.

F. Summary

34. The above discussion on the equipment market and the Company's sales to it is summarized below. The sales estimates are considered generally reasonable in view of its position as the sole domestic primary equipment supplier. The remainder of the market is expected in the near future to be serviced through imports and for some general items through existing domestic suppliers.

Plant Equipment Market in Korea and HII Sales
(Constant 1976 US$ millions)

Equipment Market	1978	1979	1980	1981	1982	1983	1983 %
Demand							
Steel-making	108	194	252	223	200	200	24
Power Generation	510	445	483	443	445	445	54
Chemical/Petrochemical	140	150	140	140	180	180	22
Total	758	789	875	806	825	825	100
Market Available to Project	243	559	702	785	825	825	
Supply							
HII Sales							
Steel-making	6	29	40	48	66	77	9
Power Generation	28	73	118	123	142	160	19
Chemical Petrochemical	4	25	25	60	80	80	10
Subtotal	38	127	183	231	288	317	38
Value Added (In-plant) %	49	55	62	69	76	81	
HII Share of Market available %	16	23	26	29	35	38	
Imports and Other Domestic Suppliers							
Steel-making	102	165	212	175	134	123	15
Power Generation	482	372	365	320	303	285	35
Chemical/Petrochemical	136	125	115	80	100	100	12
Subtotal	720	662	692	575	537	508	62
Total	758	789	875	806	825	825	100

G. Market Issues and Risks

35. The major issues and risks related to the market for the Project can be discussed along the following dimensions:

(i) Timing: The Project timing is critical in that it matches the bulk of the investment planned for the fourth Five-Year Plan. Any delays in Project implementation could have serious consequences by effectively eliminating large portions of the chemical and power sectors and POSCO's fourth expansion. In this regard HII is partially protected through the availability of the Gunpo facility, where it could take up the manufacture of the less complex items before the Project becomes operational;

(ii) Market Acceptance: The manufacturer's reputation and track record are important in the marketing of the complex systems, that form the Project's output. Lacking a track record, HII could be faced with customers who prefer to import their requirements based on past experiences and relationships. However, it is early successful entry into the domestic market that would permit HII to build its reputation. KECO and POSCO are both Government enterprises and will support the policies favoring domestic procurement but only if they see it as not adversely affecting their operations. On the positive side, there could be a significant advantage to these companies to secure a reliable domestic source of supply of equipment from the view of after-sales service and replacement parts. Also, HII's relationship with licensors who are amongst the leading manufacturers in their areas and the proposal to offer joint licensor-HII performance guarantees on early contracts should further lower the risk. As discussed in Annex 3-3, HII further plans to devote considerable effort in building up customer relations. On a price basis, the Project is expected to be fully competitive from the start if provided an opportunity to compete, despite its lack of experience in these areas;

(iii) Technological Risk: In view of the complexity of the products, quality could in itself pose a significant risk. The risk is planned to be protected against through a comprehensive implementation of the technology transfer function and a very gradual upgrading of in-house content. In this regard, HII plans to develop technically achievable localization targets;

(iv) Market Size: The market size could be adversely affected if current plans are deferred or the market available to HII could be curtailed if some projects are financed through tied credits. As indicated earlier the Project has the flexibility to enter other markets and in any event would be in a position to manufacture under subcontract for other companies. In addition, the domestic replacement market, subcontracts to licensors for plants sold in neighboring areas and direct exports provide an added margin of safety; and

(v) Financing of Sales: Another potential risk to the Project is the availability of financing for its products and the related preference for imports with associated credit arrangements. However, financing mechanisms, such as the National Investment Fund, already exist and the Government plans to strengthen these to meet the needs of this project and other such projects.

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ANNEX 3-2
Table 1

KOREA

HEAVY MACHINERY PROJECT

EXISTING STEEL-MAKING PLANTS (1976)

(000 Tons Crude Steel/Year)

	LD Converter	Electric Furnace	Open Hearth Furnace	Total
Pohang Iron and Steel Co.	2,600	-	-	1,600
Dong Kuk Steel Co.	-	545	-	545
Puchon Iron and Steel Co.	-	260	120	380
Kangwon Industrial Co.	-	370	-	370
Kuk Dong Steel Co.	-	180	-	180
Korea Iron and Steel Co.	-	130	-	130
Korea Heavy Machinery Co.	-	110	-	110
Others (8)	-	215	-	215
Total	2,600	1,810	120	4,530

Source: Korea Iron and Steel Association

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ANNEX 3-2
Table 2

KOREA

HEAVY MACHINERY PROJECT

PRODUCTION CAPACITY OF POSCO

(Crude Steel Base)

Plant	Unit	1st Stage 70.4 - 73.7	2nd Stage 74.6 - 76.5	3rd Stage 75.8 - 79.4	4th Stage 79.5 - 82.6
Sintering Plant	T/D	3,650	9,670	21,430	33,190
Coke Plant	T/D	1,600	4,100	8,350	12,600
Blast Furnace	T/D	2,600	6,480	14,020	21,560
Steelmaking Plant	'000 T/Y	1,032	2,600	5,500	8,500
Lime Calcining Plant	T/D	200	500	1,100	1,700
Continuous Casting	'000 T/Y	-	670	700	2,900
Blooming Mill	'000 T/Y	1,010	1,850	4,650	5,350
Billet Mill	'000 T/Y	148	148	700	700
Wire Rod Mill	'000 T/Y	-	-	465	465
Plate Mill	'000 T/Y	400	400	1,800	1,800
Hot Strip Mill	'000 T/Y	607	1,637	2,000	5,000
Cold Rolling Mill	'000 T/Y	-	530	562	800

Source: POSCO

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HEAVY MACHINERY PROJECT

LOAD FORECAST (1976 - 1986)

	Unit	1975 (Actual)	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Total Energy Sales	GWH	16,630	19,600	22,979	26,439	30,107	34,225	38,963	43,794	49,150	55,174	61,947	69,260
Lighting	GWH	2,130	2,500	2,900	3,289	3,701	4,160	4,675	5,251	5,899	6,627	7,447	8,372
Small Power	GWH	3,420	4,000	4,660	5,334	6,002	6,738	7,546	8,430	9,391	10,467	11,672	12,977
Large Power	GWH	10,996	13,000	15,300	17,676	20,244	23,147	26,542	29,893	33,620	37,820	42,548	47,620
Agricultural Power	GWH	84	100	119	140	160	180	200	220	240	260	280	300
Rate of T & D Loss	%	11.3	11.1	10.7	10.3	9.8	9.4	9.0	8.7	8.5	8.3	8.1	8.0
Net Generation	GWH	18,752	22,047	25,732	29,475	33,378	37,776	42,816	47,967	53,716	60,168	67,407	75,292
Rate of Plant Use	%	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Gross Generation	GWH	19,837	23,330	27,230	31,190	35,321	39,975	45,308	50,759	56,842	63,670	71,330	79,674
Average Generation	MW	2,265	2,663	3,108	3,561	4,032	4,563	5,172	5,794	6,489	7,268	8,143	9,095
Annual Load Factor	%	67.6	67.8	67.8	67.0	67.5	67.5	68.0	68.0	68.0	68.0	68.0	68.0
Peak Demand	MW	3,351	3,930	4,584	5,315	5,973	6,760	7,606	8,521	9,543	10,688	11,975	13,375

Source: Korea Electric Company

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ANNEX 3-5
Table 5

ANNEX 3-2
Table 4

KOREA

HEAVY MACHINERY PROJECT

POWER SYSTEM EXPANSION PROGRAM, 1976-1986

Plant	Capacity (MW)	Year of Completion	Total Cost (Constant 76) (US$ Millions)	Unit Cost ($/kw)
Thermal Power Plants				
Yeosu #2	300	1976	64.8	216
Inchon #3, #4	325 x 2	1977, 1978	154.1	237
Ulsan Combined Cycle	**300**	**1979**	**90.3**	**420**
Yongdong #2	200	1979	108.2	541
Asan #1, #2	300 x 2	1980	252.0	420
Yongwol and Gunsan combined cycle	300 x 2	1978	180.7	251
New Thermal #1, #2	300 x 2	1980, 1981	252.0	420
Coal-oil #1, #2	200 x 2	1981	218.9	547
New Thermal #3	500	1981	193.0	384
New Thermal #4	500	1982	193.0	384
New Thermal #5, #6	500 x 2	1983	386.0	384
New Thermal #7	500	1983	194.4	389
New Thermal #8, 9. 10	500 x 3	1985	583.2	389
New Thermal #11	500	1986	194.4	389
Nuclear Power Plants				
Kori #1	595	1977	354.0	595
Kori #2	650	1983	751.0	1,155
Wolsung #1	679	1982	1,008.0	1,422
Nuclear #5	900	1984	912.6	1,014
Nuclear #6	900	1985	778.7	865
Hydro Power Plants				
Chung Pyung	400	1980	137.0	343
Samranjin	300	1982	108.0	360
Hapchun	400	1985	137.0	343
Tidal	400	1986	480.0	1,200
Small Hydro Plants (8)	50-210	1976-86	N.A.	N.A.

Source: Korea Electric Company - Long Range Development Program 3/77

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HEAVY MACHINERY PROJECT

PRODUCTION AND IMPORT OF MAJOR PETRO-CHEMICALS[1/]
(000's MTY)

Description	1968			1974			Increase in Consumption 1968 to 1974 (Times)	Self-Sufficiency 1974 (%)
	Production	Import	Apparent Consumption	Production	Import	Apparent Consumption		
LD-Polyethylene	-	19	19	67	8	75	3.9	89
HD-Polyethylene	-	5	5	-	15	15	3.0	0
Polypropylene	-	2	2	54	5	59	29.5	91
PVC	15	1	16	67	5	72	4.5	93
VCM	7	6	13	72	-	72	5.5	100
Polystryrene	1	2	3	10	4	14	4.7	71
Arylonitride	-	10	10	34	28	62	6.2	55
Caprolactam	-	7	7	10	34	44	6.3	23
DMT	-	1	1	1	69	69	69.0	0
TPA	-	1	1	-	69	69	69.0	0
SBR	-	3	3	10	15	25	8.3	40
Alkylbenzene	-	1	1	8	-	8	8.0	100
Phthalic Anhydride	1	3	4	8	1	9	2.2	89
Methanol	-	30	30	60	-	60	2.0	100
Carbon Black	-	5	5	17	3	20	4.0	85
Ethylene Glycol	-	1	1	-	28	28	28.0	0
Styrene Monomer	-	2	2	-	18	18	9.0	0
Total	24	99	123	418	302	720	5.8	58

Source: Korea Traders Association

1/ Excludes ethylene, for which data was not available. Demand in 1975 amounted to 189,000 tons.

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HEAVY MACHINERY PROJECT

DEMAND FORECAST OF CHEMICAL AND PETRO-CHEMICAL PRODUCTS

Unit Petroleum : 1,000 BBL
Refinery plant equivalent: 1,000 BPSD
Petro-chemical : 1,000 MTY

Product	1975	1976	1977	1978	1979	1980	1981	Annuan Average Growth Rate(%)	1986
Petroleum	113,618	124,369	133,578	145,413	162,042	178,550	196,627	9.6	303,000
(Refinery Plant Equivalent)	391	427	460	501	558	613	677	9.6	1,050
Petro-Chemicals									
Ethylene	189.1	265.2	321.9	397.6	488.8	576.1	579.7	20.1	934
LD-Polyethylene	74.1	88.3	105.9	127.5	152.5	183.0	213.2	19.3	344
HD-Polyethylene & Poly Propylene	85.3	100.4	116.3	137.2	198.7	242.7	253.5	19.9	409
Polystyrene	17.4	21.1	26.4	33.0	41.3	51.6	66.3	25.0	107
VCM	70.7	92.7	97.8	144.6	176.0	226.0	226.0	21.4	364
EDC	50.7	55.8	55.8	55.8	193.0	286.0	286.0	33.4	461
Styrene Monomer	21.5	32.5	41.3	53.4	69.0	69.0	72.6	22.5	117
Caprolactam	61.3	81.5	98.3	110.1	116.6	122.7	133.0	13.8	215
Phathalic Anhydride	12.9	16.2	18.7	27.0	27.0	28.2	32.6	16.7	53
Acrylonitride	84.8	92.4	99.9	103.4	106.6	112.6	118.3	5.7	191
DMT/TPA	112.3	142.3	158.9	188.1	205.5	222.5	236.4	13.2	381
Ethylene-Grycol	46.9	57.6	64.2	76.5	83.7	90.9	96.3	12.7	155
SBR	25.0	31.4	38.3	46.5	56.5	68.4	87.9	23.3	142
Methanol	85.0	310.0	390.0	390.0	390.0	390.0	390.0	28.9	628
Total	937.0	1,388.4	1,633.7	1,890.3	2,305.2	2,669.7	2,791.8		4,501

Note: Demand of 1986 is estimated on the following basis of annual average growth rate during 1982-1986.
Petroleum: 9%
Petro-chemicals: 10%

Source: 4th Five-Year Plan Documents

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ANNEX 3-2
Table 6

KOREA

HEAVY MACHINERY PROJECT

PETRO-CHEMICAL PLANTS IN KOREA (1975)

	Capacity ('000 t/y)	Year of Completion
Ulsan Complex		
Naphtha Cracker	100	1972
ID - Polyethylene	50	1972
VCM	60	1972
Acrylonitrile	27	1972
Polypropylene	45	1972
Phyhalic Anhydride	8.4	1973
Polystyrene	50	1974
Caprolactam	33	1974
Ethanol	30	1974
Acetaldehyde	24	1974
SBR	25	1975
HD - Polypropylene	35	1975
Other Production		
PVC	86	1966
Carbon Black	30	1969
Methanol	15	1969
Acetic Acid	30	1971
Methanol	45	1971

Source: Ministry of Commerce and Industry

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HEAVY MACHINERY PROJECT

CHEMICAL/PETRO-CHEMICAL INVESTMENT PROGRAM, 4TH PLAN (1977-81)

Investment: $1,000

Project	Capacity	Name of Company	Investment
Petroleum Refinery Plant	(1,000 BPSD)		
New Construction	180		
Expansion	60		332,600
Petrochemical Plant	(1,000 MTY)		
Yeochun Naptha Cracking Center	350	Honam Ethylene	226,417
HD-Polyethylene	70		
Ethylene-Grycol	80	Yeosu Petro-Chemical	311,576
Polypropylene	80		
Butadien	50		
LD-Polyethylene	100		
VCM	150	Hanyang Chemical	98,479
EDC	286		
TPA	100	Samsung Petro-Chemical	69,678
Styrene Monomer	60	Ulsan Petro-Chemical	22,422
Caprolactam	100	Korea Caprolactam	111,320
Phathalic Anhydride	15	SamKyung Chemical	9,222
Ulsan Naphtha Cracking Center	50	Korea Oil Corp.	16,940
SBR	25	Korea Synthetic Rubber	10,182
ABS	6	Korea Synthetic Rubber	8,443
Sub-Total			884,679
Pulp Plant	300 T/D		91,264
Other Chemicals		Fine Chemicals etc.	580,000
Total			1,888,543

Source: 4th Five Year Plan

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HEAVY MACHINERY PROJECT

CHEMICAL/PETRO-CHEMICAL INVESTMENT PROGRAM, 5TH PLAN (1982 86)

Unit Cap.& Demand: 1,000 MTY
Investment : $1,000

Project	Production Cap.of 1981	1986 Demand	1986 Production	Expansion (82-86)	Investment
Petroleum Refinery Plant (000 BPSD)	675	1,050	1,050	375	525,000
Petro-Chemical Plant					
Ethylene	500	934	869	369	145,000
LD-Polyethylene	150	344	320	170	75,000
HDPE & Polypropylene	230	409	380	150	115,000
Polystyrene	50	364	100	50	20,000
VCM	225	461	339	114	26,000
EDC	286	117	429	143	39,000
Styrene Monomer	60	215	109	49	13,000
Caprolactam	133	53	200	67	100,000
Phthalic Anhydride	27	191	49	22	11,000
Acry-onitride	27	381	178	101	66,000
MDT/TPA	100	155	354	254	200,000
Ethylene-Grycol	80	142	144	64	10,000
SBR	50	628	132	82	74,000
Methanol	390		584	194	60,000
Sub-Total					954,000
Pulp Plant	182	970	485	303	279,000
Other Chemicals					800,000
Total					2,558,000

Note:

1) Production capacity of 1986 is estimated on the following basis of self-sufficiency rate:
   Petroleum refinery plant: 100%
   Petro-Chemical plant : 93% based on that of ethylene in 1981.
   Pulp plant: 50%

2) Investment is estimated on the basis of unit prices derived from the 4th Plan.

Source: HII Project Document

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KOREA

HEAVY MACHINERY PROJECT

POWER GENERATION EQUIPMENT MARKET
(Real 1976 US$ millions)

Type of Facility	1977	1978	1979	1980	1981	1982	1983
Thermal							
Investment	262	290	358	400	404	409	409
Primary Equipment	145	160	197	220	222	224	224
Nuclear							
Investment	301	510	353	384	329	387	287
Primary Equipment	196	331	229	250	214	186	186
Hydro							
Investment	31	54	53	38	20	100	100
Primary Equipment	11	19	19	13	7	35	35
Total Primary Equipment	352	510	445	483	443	445	445
Market Available to Project	-	75	255	350	420	445	445
HII Sales	-	28	73	118	123	142	159.6
HII Market Share	-	37%	29%	34%	29%	32%	36%

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ANNEX 3-2
Table 10

KOREA

HEAVY MACHINERY PROJECT

MARKETING ORGANIZATION AND STRATEGY

1. The marketing organization at HII has in the past been directed towards domestic sales of Gunpo and Anyang products. The marketing responsibility is divided by product group with managers responsible for sales of automotive parts, construction machinery, heating and cooling equipment, and castings and forgings, directly reporting to the Senior Director for marketing. In the recent past, HII added another arm to its marketing unit by setting up a unit for Project sales to promote sales of plant equipment to be manufactured at Gunpo and under the Project (Annex 2-2). In this area, the Company proposes to continue this overlap between existing operations and the Project, in view of the similar nature of the marketing function for sales of plant equipment to different industries.

A. Development of Proposed Organization

2. The Project sales department at HII currently comprises around 40 staff (9 overseas) drawing additional support from the technical and operational staff of the Company, as necessary. The staff report to four managers:

(i) Manager of Power Plant Sales: Responsible for coordinating with General Electric (USA) in submitting joint bids where HII would contribute the required local content, presently through Gunpo operations. The manager is also responsible for the early development of the steel mill machinery market;

(ii) Manager of Chemical Plant Sales: Responsible for promoting and advertising the Company's future production capabilities in this area and ensuring HII involvement at the inception stage of chemical projects;

(iii) Managers of Textile and Paper and Pulp Plants: Responsible for domestic sales of these plants proposed for manufacture beginning in 1977. In these areas, the Company has been actively negotiating orders for construction of plants between 1977 and 1979; and

(iv) Manager of Cement Plant and Export Sales responsible for cement plant sales to the domestic and export markets and also for exports of special order forgings, castings and fabrication products. The two functions have been combined in view of HII's cement plant marketing being largely oriented towards exports. The Company carries out the export function through travel, supported by four overseas offices in London, San Francisco, Sydney and Tokyo.

3. As a first step towards building a marketing capability for the products of the Project, HII proposes to appoint a manager for marketing steel mill machinery and set up the support function staff for market research and product pricing and costing. In these areas, the staff will operate within the framework and policies set by the Policy Committee and provide data to the Committee as necessary. It is planned to increase the strength of the Project sales department to around 100 by the end of 1977 and to over 200 by 1980 in order to fully support the operational capacity build-up of the Project. The staff will include a number of sales engineers, who in collaboration with the technical staff, would not only assist in assessing customer requirements but also assure adequate aftersales service. The custom and jobbing sales, unless directly related to plant equipment, will be handled through the manager for sales of forgings and castings for existing opertions. The staff in that function too will be significantly expanded. Over time, the Company plans to apppoint additional managers exclusively for ancillary and jobbing sales.

B. Marketing Strategy

4. The Company's approach to marketing the products proposed for manufacture under the proposed Project emphasizes two aspects:

(i) Close contact with the Government agencies, such as the Economic Planning Board, Ministry of Commerce and Industry and the Korea Society for Advancement of Machinery Industry, responsible for Government approval at different stages and for establishing localization plans and import regulations; and

(ii) Continuous information exchange with Project Sponsors, Pohang Steel Company, Korea Electric Company and a number of companies in the chemical area to advertise HII's capabilities, to ensure prequalification and to promote market acceptance by being involved from the earliest stages. Through this approach, the Company plans to incorporate the needs of its major customers in its own process of product selection.

5. In regard to contact with Government agencies, the marketing staff propose to be involved at the earliest stage when projects are identified by the Economic Planning Board in the development plans for the country. From these onward HII will be involved through the stages of project design, and approval, providing design information and information to assist the Government agencies in establishing local content requirements based on local manufacturing capabilities, and strengthening local capabilities. In addition, the Company is already working with the relevant agencies on issues such as standardization of processes, capacities and designs for plants in Korea especially in relation to the power generating industry.

6. Another issue proposed for discussion is the availability of adequate domestic sales financing arrangements through mechanisms such as the National Investment Fund to ensure local competitiveness with credit terms offered with imports. Availability of financing presents a major potential risk to the success of the Project as discussed in Annex 3-2. The allocation of the National Investment Fund to the Machinery Industry in 1976 amounted to around US$70 million. It would need to be expanded significantly in order to provide basic support to the machinery industry and also support sales of domestically manufactured capital goods.

7. In relation to the exchange with project sponsors, the Company plans visits for their staff to HII's Gunpo operation and offers an orientation to the capabilities of the entire Hyundai Group. The Company plans to be responsive to the needs of its major customers by seeking their inputs in the negotiation of future licenses. Where projects are identified without sponsors, such as for some chemical plants, the Company proposes to work on preliminary design of the plant and market a turnkey proposal to potential sponsors.

8. The major risk to market acceptance is based on the perceived technical capability of HII in view of the nature of the product, the importance of overall system and component reliability and the fact that HII lacks a proven track record. The Company proposes to counter this risk by relying heavily on its licensors in the early years of operation. The Company plans to bid its first few contracts jointly with its licensors, both parties providing a shared performance guarantee. The Company plans to gradually build up the local content in such bids in consultation with licensors, in line with its own capability and the establishment of its reputation as a reliable supplier in the market.

C. Pricing Policy and Terms

9. The Company has not yet developed a comprehensive pricing policy. Generally, HII plans to establish its prices in line with existing price of imports, based on information gathered from the past experience of its major customers. The market for the Company's products and its own sales (Annex 3-2) has been derived on this basis. It should be noted that the past experience relates to the most competitive bids received for earlier purchases and prices derived on that basis, adjusted for inflation to the relevant year, should assure HII's competitiveness. Further details are provided in Annex 7-1.

10. Imports of such capital goods are not currently subject to any tariffs and HII's pricing policy therefore does not assume any tariff protection against imports, though some procedural protection might well be available as the Company establishes itself as a quality manufacturer. Under such procedures, buyers of products that HII is capable of manufacturing domestically, would be asked to consider domestic purchase, and imports would be permitted only against strong justification.

11. The relationship of cost to the above prices is more difficult to assess at this time on a product by product basis given the diversity of products. But for the early years of operation, with limited sales and an extremely high content of bought-out parts, it is expected that the low labor cost of the Company would assure adequate coverage of costs. Current estimates on an aggregate basis fully support this conclusion.

12. HII plans to sell its primary products on terms comparable to those used worldwide for sale of such goods. The Company would receive 10% of sales value as an advance with the order to support engineering work, a total of 70% in progress payments spread over the period of manufacture and 10% on receipt of shipment by the customer. The remaining 10% would be paid on performance of acceptance tests, serving as a performance guarantee.

D. Export Potential

13. The discussion above largely relates to the domestic market, which would be the focus of HII's efforts in the first few years of the Project. The Company recognizes the limitations to its export potential in these early years and these have not been included in assessing the viability of the Project. However, the Company proposes to make an early start in export marketing capitalizing on the overseas position of its affiliate (the Construction Company), subcontracting requirements of its licensors and the fact that it already devotes resources to overseas marketing of castings and forgings and cement plants. The Company plans to base early exports on joint bids with licensors, an approach it is following currently in marketing cement plants (with Fuller Company of USA). The proposed early start should assist entry into export markets when HII is ready to do so on the basis of an established reputation in Korea.

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KOREA

HEAVY MACHINERY PROJECT

PROJECT DESCRIPTION

A. General Objective

1. The Government of Korea has planned for a strong and sustained growth in the fourth and fifth Five-Year Economic Development Plans in the industrial sector, particularly in the field of steel production, electric power generation and chemical and petrochemical industry. The Government's strategy is to develop the heavy machinery sector to meet the growing demand for plant and equipment. As such, the Government has given a high priority to the development of the heavy machine-building sector in its development plan and has selected Hyundai International Inc. (HII) to implement a key project in this sector. The Government is providing a wide range of support for the implementation of such a project.

2. Within this overall framework and consistent with the economic development plans of the country, HII prepared the project and it was reviewed by Ingersoll Manufacturing Consultants (IMC) of the U.S.A. The project will be the first of its kind and magnitude in Korea. Although basic project parameters have been finalized, the details are still being worked out with the help of experienced foreign consultants and licensors. The project is proposed to be located at Changwon on the southeast coast of the Korean Peninsula, close to the Changwon Industrial complex (See Map IBRD 12644). The selection of this project site is consistent with the Government's desire to develop Changwon as an excellent industrial center with a heavy machinery base. The plant is well situated, with respect to raw materials and component supply, availability of infrastructure and labor, market and future prospects for exports of machinery and plants.

B. Overall Concept

3. The Project is primarily designed to manufacture most of the equipment required for steel plants, power generating plants and chemical and petrochemical plants, with sufficient flexibility to produce products with some or all of the following characteristics:

a) large custom-built equipmemt, in line with users' requirements and specifications;

b) extra large dimensions and/or heavy weights;

c) operation at very high temperatures and pressures;

d) rotation at high centrifugal speeds;

e) equipment requiring extra-thick materials and involving high strength properties;

f) high accuracy with very close tolerance levels; and

g) rigid quality assurance standards at all stages of manufacture, assembly and testing.

4. The facilities under the Project will be highly flexible, versatile and capable of producing a wide range of heavy industrial equipment and machinery. The design of the plant recognizes that each of the major products is technically complex requiring a high degree of engineering work, manufacturing skills and significant expertise in assembly and testing. Moreover, each product has to function, with high reliability, as a part of a system in an industrial plant or in a power plant. As a manufacturer of such equipment, HII will, therefore, be regarded as being responsible for efficient functioning of the whole system. In addition to major equipment manufacture, the project is also designed to undertake minor jobbing works to balance the cyclic load inherent in a project of this type.

5. The production capacity of the project is based on the following:

(i) 1,000 MW of power plant each year;

(ii) one steel plant with 3.0 million tons output every three years;

(iii) a complete array of equipment required for a chemical and petrochemical plant; and

(iv) some fabricated items, forging and castings to achieve maximum capacity utilization.

These products require a wide variety of equipment and machinery and the project is expected to achieve an annual output of 100,000 TPY at its steady state to be reached in 1983.

6. In the design of the project, due consideration has been given to factors such as planned product mix at the steady state based on market requirements, specific product and technology requirements, desirable import substitution levels, the optimal trade-off between the use of labor and equipment, local availability of materials and components, site conditions, efficient material flow for products and future potential expansion requirements, in developing basic parameters for the following areas:

a) process selection and equipment requirements,

b) space allocation and plant layout,

c) manpower requirements, and

d) technology requirements (licenses)

7. The initial equipment requirements and configuration were developed, based on discussions with major licensors, to meet the needs of individual products. This initial configuration was then consolidated to remove any duplication of under-utilized equipment capacity. Improvements were then made to achieve higher overall productivity by rationalizing equipment sizes and types and substituting more appropriate machinery for the proposed product mix. To increase flexibility to produce various heavy machinery, without significantly impairing productivity, some additional modifications to the process and equipment selection were made. Some of the highly specialized equipment used by high-volume, single-product manufacturers has been replaced with semi-specialized or general purpose machine tools with special attachments to increase versatility and to reduce unnecessary investment needs. This would also allow increased utilization of low cost skilled labor. A size and weight capability to match a broad base of industrial machinery products has been included in critical areas of production. Equipment and machinery required to produce items which are relatively easy to subcontract either within the Company or to other manufacturers, were eliminated. Specific areas, in this regard, are light machining, gear making and light fabrication. In order to reduce project cost, to provide manufacturing load during the start-up phase and to demonstrate HII's manufacturing capabilities, some equipment, which is required for the project, was identified as potentially suitable for manufacture by HII under licenses or manufacturing agreements with relevant equipment suppliers. Detailed plans for these types of equipment are being presently developed.

8. Space requirements were established by comparing HII's planned production volume to existing facilities of licensors for similar annual through-put and also taking into account the future expansion requirements. The rationale for the general plant layout and space allocation is given in Annex 4-2. In developing the manpower requirements for the project the following factors were considered: local labor productivty; the number of people required for operation of each machine and for non-machining operations; and the experience in the facilities of licensors or manufacturers of similar products and through-put. Further details are contained in Annex 4-7. Since the level of technical complexity in most of the products is high during engineering and manufacturing stages, the need to establish a broad technology base was given full consideration in the Project design.

C. Project Scope

9. The project consists of the following major facilities:

1. Foundry and Forge shops;

2. Fabrication shops;

3. Machine shops;

4. Assembly and Test shops;

5. Support facilities; and

6. Other auxiliary facilities.

The plant layout, and material flow diagrams for typical products are given in Annexes 4-2 and 4-4 respectively.

1. Foundry and Forge Shops

10. A wide variety of castings and forged parts are required for the production of machinery envisaged in the project. The weight of each casting will vary from 200 tons to less than 500 kg per piece. Similarly the weight of forged parts would also vary between 200 tons to less than 500 kg. Small castings and forged parts up to 5 tons will be purchased from existing producers in the country, including HII's Gunpo plant. The maximum weight and size of castings and forged parts were the main consideration in selecting the equipment for this plant. The capability to produce such large castings and forgings will provide the necessary technology base and flexibility for the manufacture of products involved, and better control of production cost and delivery. However, this facility will have some surplus capacity to meet the needs of other industries in the country.

11. According to the present production program, the largest casting to be produced would weigh around 200 tons. However, the project has the capability to produce heavier than 200 ton castings utilizing electro slag welding techniques, which are well established in plants in the U.S.A, Western Europe and Japan. The forge shop is planned to produce shafts, blanks and rings needed in most of the products. The ability to forge successfully the large shafts, such as turbine rotors, will depend on the availability of high quality ingots from the foundry. These parts have stringent metallurgical and quality requirements that are sometimes difficult to meet even for internationally renowned manufacturers. With appropriate know-how and technical assistance, HII will be able to manufacture increasingly large shafts up to a maximum 200 tons ingot weight.

12. To ease material handling, the foundry and forge shops are located in adjacent buildings. The foundry shop will cover an area of 35,500 m^2 (275 m x 80 m and 300 m x 45 m) with two 20 m bays, one 25 m bay and one 30 m bay. The highest and lowest distance under the crane hook will be 16 m and 21 m respectively. The forge shop will occupy an area of 30,000 m^2 (300 x 100 m) with one 15 m bay, two 25 m bays and one 35 m bay. The maximum distance under the crane hook will be 25 m. Sufficient lifting capacity (a maximum of 250 tons) has been included in both shops and the two shops will be linked by rails to facilitate transfer of work-pieces. The elevation of these shops will be 8 m above mean sea level. They have been located in the northeast corner of the site, in view of prevailing wind direction, to avoid pollution from dust and fumes. The shops additionally include necessary pollution control devices such as electrostatic precipitators, "bag filters" for fumes, and dust-collection systems.

13. The foundry shop will have the following equipment: one 100-ton arc furnace, one 100-ton holding furnace, one 20-ton arc furnace, one degassing facility a number of ingot mold and ingot mold cars with capacities varying from 10 to 200 tons, sand preparation plant including necessary conveyer systems, and necessary auxiliary facilities. The melting capacity of the foundry on a 300-day working year will be about 110,000 tons per year. The maximum pouring capacity of this foundry will be about 240 tons. The casting areas for the small and large castings will be separate: the large casting pit will be 40 m long, 6 m wide and 2.5 m deep with provisions for partitioning. Molding sand for both these casting areas will be fed by a continuous mixer through a conveyer system from the sand preparation plant. This shop will be constructed in two stages. The 20-ton arc furnace and most other facilities will be completed in the first stage. By utilizing these facilities HII, under manufacturing or licensing agreements, will construct in the second stage the 100-ton arc furnace, 100-ton holding furnace, some ingot mold cars and ladles. This knocked down kit approach for stage two, whereby HII will obtain the essential components and drawings from the suppliers, is considered appropriate for this project and will reduce the investment requirements.

14. The forge shop will include the following equipment: one 3,000-ton hydraulic press, one 8,000-ton hydraulic press, two manipulators (50-ton and 200-ton), ring rollers, and vertical heating furnace. Like the foundry shop, this will also be implemented in two stages: (i) the small hydraulic press (3,000 ton) and associated manipulator (50-ton) and other supporting facilities will be implemented in the first stage and (ii) the large hydraulic press (8,000-ton) including its manipulator (200-ton) in the second. Assuming an average ingot weight of 100 tons and six-hour working period per piece, the capacity of the forge shop will be about 24,000 tons per year.

15. The foundry and forge shops will also include other supporting facilities such as heat treatment facilities, soaking pits, fettling equipment, shot blast equipment and necessary equipment for testing and quality control. These shops are very large even by international standards, and have ample capacity to support the proposed product mix.

2. Fabrication Shops

16. In order to improve operational efficiency, the fabrication functions will be located in two separate buildings one for flat steel fabrication and another for non-flat steel fabrication. The flat steel fabrication shop will occupy an area of 35,000 m^2 (250 m long and 140 m wide) at a mean elevation of 5.5 m above M.S.L. This plant is capable of producing very high-capacity and high pressure vessels and boilers. This shop will have one 50 m bay, and three 30 m bays and is capable of processing steel plates of up to 250 mm thickness and products weighing up to 240 tons. The non-flat steel fabrication shop will have an area 20,000 m^2 (200 m long and 100 m wide) and will be divided into five 20 m bays. This shop is

designed to fabricate tubular components and pipe wastes. One transfer bay, mainly for preparation and transport of raw materials into the fabrication areas, is also included in both the fabrication shops. Adequate lifting capacity is also planned in both the shops.

17. The equipment in the fabrication shops consists of one hot roll bender for plate up to 160 mm thickness and another for up to 25 mm, one 8,000 ton hydraulic press, one 600-ton straightening press, shears, press brakes, power rollers, horizontal boring bar, radial drills, various types of welding equipment including submerged arc, electro slag, MIG and TIG welding equipment, necessary cutting equipment including plasma arc cutting torch, tube benders, pipe benders, manipulators, rotary positions of different capacities, weld tables, burning tables, necessary supporting facilities and machine tools and all the required testing and quality control equipment such as portable magna-flux testers, fluoroscope machines, ultrasonic testers, X-ray equipment and pressure test equipment. These shops are capable of producing most of the heavy fabricated vessels and equipment. Some of the equipment such as two roller benders, three press brakes, positioners and miscellaneous tables will be manufactured by HII under the knock-down kit approach.

18. The Hyundai Group has considerable knowledge in the fabrication area, primarily acquired through its ship building facilities. However, the fabrication requirements of the project are much more complex because of the nature of the materials and products (high strength and heavy materials and very close tolerance requirements) and the fabrication techniques involved. Some of the welding and cutting techniques will be new to the country. Since the manufacturing technology involved in fabrication is an extension of that already existing within Hyundai Group, HII is expected to have a comparatively fast learning curve in the fabrication area. A portion of the fabrication shop will be one of the first facilities to be completed, since it will be used for fabrications needed for the Project.

3. Machine Shops

19. The machine shop, which requires the highest investment in production equipment, will signify the largest advance in technology. The machine shops are divided into two categories; heavy machine shop and light machine shop. While the inputs used in the heavy machine shop will be heavy castings, forging and fabricated products, the light machine shop will consume various types of bar stocks to produce light parts for final assembly and jigs and fixtures for the heavy machine shop. The machinery requirement in the light machine shop is kept to the bare minimum, taking into account the fact that light machining capabilities are already available in the country. The heavy machine shop is the most important facility in the Project and the success of the Project will greatly depend on its efficient operation. Therefore, final details of this shop have been developed with the assistance of experienced consultants.

20. To minimize the cross flow and material handling requirements, the heavy machine shop and the assembly shop will be in one building (380 m long and 140 m wide), and the light machine shop will be adjacent to the heavy machine shop. The areas of the heavy and light machine shops are as follows:

Heavy machine shop - 35,700 m^2 (2 bays of 40 m and 2 bays of 30 m, all of 255 m long)

Light machine shop - 15,000 m^2 (3 bays of 20 m and 250 m long)

Both the shops have appropriate lifting capacity for materials handling. The maximum lifting capacity in the heavy machine shop is about 300 tons (utilizing one 50-ton crane and one 250-ton crane included in this shop).

21. The components to be manufactured in the heavy machine shop fall into two major categories.

- cubic parts (rolling mill stands, turbine casing, etc.)

- cylindrcial parts (rotors, rolls, etc.)

The basic manufacturing route for cubic parts is through surfacing, rough boring, drilling and finish boring; for cylindrical part the route is horizontal turning, flat surfacing and drilling, and grinding. The size and weight of the parts involved dictate the primary manufacturing flow within each bay and the type of machine to be utilized. The machine tools included in the project are sufficient to meet the size and capacity for the planned products. The light machine shop will contain a wide range of smaller general purpose machine tools and some special equipment to provide a capability to machine turbine blades. A substantial volume of small part machining will be subcontracted or manufactured at Gunpo Plant.

22. Although the basic equipment and machine tools required for both heavy and light machine shops have been developed, this list will be reviewed further by the Company with the help of qualified consultants. The machine tools, including heavy ones, included in the heavy and lighter machine shop will total about 130 and comprise the following major equipment:

		Total	Heavy	Light
(i)	adjustable rail-milling machines (maximum size: table 6.25 x (2) 10 m)	5	5	-
(ii)	Horizontal Boring Machines (maximum size: 200 cm diameter raw)	14	12	2
(iii)	Vertical Boring Machines (maximum size: 8.5 m table/ 12 m swing)	15	9	6
(iv)	Horizontal Turning Machines (includes N/C machines: Maximum size: 3.6 m diameter x 12 m)	16	7	9
(v)	Drilling Machines (maximum size: 100 m spindle, 3 m x 4 m travel)	23	5	18
(vi)	Grinding machines, including one N/C (maximum size: 2.5 m diameter x 18 m)	6	2	4
(vii)	Gear making machines	2	-	2
(viii)	Blade making machines	14	-	14
(ix)	Miscellaneous small machine tools, including slotters, shapers, threaders, key scaters, etc.	35	-	35
	Total number of machine tools (about)	130	40	90

23. The maximum size of milling, boring, turning and grinding machines included in the Project will allow HII to manufacture the largest size of equipment required under the production plan. Moreover, since most of these machine tools are semi-specialized or general purpose machines, this shop has sufficient flexibility in the production of various types of equipment. Although some machines are provided for the manufacture of large turbine blades for many of the stages in the high-pressure cylinder and medium-pressure cylinder, where the manufacturing process is not too complicated), HII will enter into this area only very gradually. The blades required for the low-pressure stages will be the most complicated area and the mastery of this technology will require more time. Therefore, these items will be imported and hence machine tools required for these are not included in the project. In addition to the machine tools, the heavy machine shops will also have necessary heat treatment, storage, and handling facilities. On the whole, the equipment selection and space allowed in the machine shops are considered adequate.

4. Assembly and Test Shop

24. The products to be assembled in this shop will require very large, heavy and complex equipment. So, to minimize material handling of intricate and heavy pieces, the assembly shop and the heavy machine shop will be under one roof, with sufficient provisions for overhead cranes to cover both the shops without difficulty. Since the machinery and equipment to be assembled are very large, a great amount of space is required in the assembly plant. The assembly plant will have an area of 17,500 m^2, with two 40 m bays and two 30 m bays -- extension of the heavy machine shop bays. Most of the equipment required in this facility is selected on the basis of easy maneuverability for assembly and test purposes of various heavy products. Therefore, the fixed facilities in this shop will be kept to a minimum to ensure the flexibility needed to match a constantly changing work load. However, among the products, the steam turbine and generator require certain special facilities, which are included in this shop. The 40 m bay, where the largest pieces will be assembled, will have one 400-ton overhead crane, and the other bays will have necessary lifting capacity to handle the planned production.

25. The major equipment in this shop will include the following: precision balancing facility, erection platforms, winding and assembly equipment for generators, baking ovens, shrinking ovens, transposition tables, brazing equipment, necessary quality control and testing equipment and appropriate jigs and fixtures. Since most of the items, with the exception of precision balancing facility and testing and quality control facilities, are required only at the end of the Project implementation and can be produced in other facilities of the Project, HII will adopt the knock-down kit approach for fabricating and installing these facilities.

5. Support Facilitie

26. The support facilities, most of which will be located between the two fabrication shops will consist of the following: large heat treatment facility, grit blast and painting facilities, X-ray facilities, maintenance shop, central tool room and materials handling. The heat treatment facility will have a large stress relief furnace capable of accommodating large castings, forgings and fabricated products. The grit blasting and painting shop will also include facilities for accommodating large sub-assemblies and final fabricated products. Necessary pollution control equipment is included in the heat treatment, grit blast chamber, and painting shop. The centralized X-ray testing equipment will be located in a fully covered concrete building. The maintenance facilities will contain small machine tools required for the repair work of tooling, production equipment and buildings. The central tool room will consist of about 30 small machine tools, such as lathes, milling machines, jig borers, shapers, tool grinders and tool cutters.

27. As mentioned earlier, the material flow has been one of the primary factors considered in developing the proximity requirements for the different manufacturing activities. Intra-building movement of heavy parts, to the extent feasible, is planned to be through individual bays using overhead cranes. Where cross bay movement is required, transfer cars will be utilized for materials handling. Single-log gantry or jib cranes will handle material movement within localized areas. The flow of components and parts will be transported by fork-lift trucks. Intra-building movement of major heavy parts, which will be kept to a minimum, will be accomplished using multi-wheel load spreading vehicles. Some rail-mounted transport facilities will also be available for the transport of large items to and from the common facilities of heat treatment, X-ray test, grit blast and paint. The project includes necessary materials handling equipment, including a 450-ton multi-wheel loader and a 150-ton rail car.

6. Other Auxiliary Facilities

28. Electricity: The three phase electrical power, at a voltage of 154 KV and at a frequency of 60 Hz, will be transmitted to the sub-station at the plant through two 154 KV incoming circuit breakers each with power metering equipment. The transformer station will have four 40 MVA transformers to meet up to a maximum demand of 156/160 MVA, which is more than adequate for the proposed facilities. The distribution network within the plant will have two HV networks at 22.9 KV and 6.6 KV and one LV at 400 - 440 volts. (Refer to Chart 1 of Annex 4-8 for further details.) Power factor correction will be applied to the distribution network, which will be carried out completely by underground cables. At the location of large loads, where significant savings in distribution cabling is possible, individual correction will be applied.

29. Water, Steam, Compressed Air, and Fuel Oil: Total water requirements of the project will be about 5,000 m^3/day, of which 60% would be for industrial use. This is based on the provision that a recirculation system for the foundry shop will be established and a separate system for fire fighting facilities will be available. Two water storage tanks, necessary distribution network and disposal system, including a waste water treatment plant, are included in the project. Since major production facilities are located in different buildings and the requirements vary among shops, a central steam generation and a compressed air station are not considered appropriate for the project. Each facility, based on its needs, will have its own means for providing steam and compressed air. At steady state, the Project would require about 2,000 tons of steam per day and about 15,000 m^3/hr of compressed air at 7 kg/cm^2. The fuel oil (Bunker-c oil) required for the Project, primarily for steam boilders and heat treatment facilities, woudl be about 300,000 M/T per year. Necessary facilities to meet this requirement have been incorporated into the Project.

30. Argon, Oxygen, Co_2 and Acetylene: Facilities necessary to produce these gases are not part of this project. Adequate storage facilities, however,

have been provided for sustained production at a steady state. All these gases are required for welding and cutting functions. At steady state the total need per day would be about: Argon, 110 m^3; oxygen, 2,250 m^3; CO_2, 220 m^3; acetylene, 200 m^3.

31. Warehouse Facilities: In addition to the storage areas provided in each major facility, centralized warehouse facilities are also included in the Project. The main warehouse, where most of the bought-out parts, spare parts and other items will be stored, will cover an area of 8,400 m^2 (120 m long and 70 m wide with one 30 m and two 20 m bays). This facility is quite adequate for the purposes of the Project. An independent underground storage facility, away from the plant, is also available for inflammable products like paints, varnishes, etc. An open area of nearly 7,000 m^2, with gravel floor and necessary gradient for drawing off water will also be provided for steel and bar stock storage. The scrap and sand storage area will be close to the foundry melting area.

32. Training School and Laboratories: A training school to train technicians and machinists will be included in the Project. Since training of workers should start before the completion of the project, this facility will be completed by the end of 1977. A central laboratory consisting of testing equipment for raw materials and components, metallurgical and metrology testing facilities, X-ray equipment and other relevant equipment will also be a part of the project.

33. Administrative and Other Buildings: An eight-story administrative building (with a total floor area of 20,000 m^2) living quarters for expatriate technicians and for some local workers, a guest house, dining facilities, dispensary and recreational facilities are also planned.

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KOREA

HEAVY MACHINERY PROJECT

PLANT LAYOUT

1. The selected site encompasses 3.24 km^2 of area on the south eastern coast of the Korean peninsula. Of this area 0.54 km^2 is to be reclaimed from the sea, which is on average 6 meters deep in the region to be filled. The area experiences moderate climatic and tidal conditions throughout the year. The site is part of the Changwon Machinery Complex and lies on the coastal belt set aside for industrial development and removed from tourist areas. The occupant enterprises in the complex are expected to be the dominant source of raw materials and components for the Project. In addition the site has access to other inland areas through a well-connected highway system. The planned availability of deep-water harbor facilities close to the site would further facilitate transportation of materials and end-products as a number of the Project's consumer industries are also located on the same coastal belt. The site area (3.24 km^2) provides adequately for future expansion as only 0.26 km^2 of area is currently taken up by the planned facilities.

2. Various ground investigations have been utilized to assess the nature and magnitude of the geological problems likely to be encountered. A seismic survey carried out by the College of Engineering of Seoul National University reveals that only normal design factors are required for design since the area is not in any earthquake zone. Standard Penetration Tests undertaken by HII indicate a steady increase of strength with depth. Over the area of site a grid of 24 boreholes were drilled, which varied considerably in depth depending on the depth to weathered rock at each location. In general, hard rock was proven to a depth of about 3 m. However, geotechnical information available suggests that careful engineering attention should be given to the development of the site and the Company is taking necessary measures to achieve proper ground conditions.

3. The plant layout was developed by HII in consultation with its technical consultants. Thereafter it was modified following discussions with the Bank. The layout will be finalized following in-depth review by the Company, its main licensors and its consultants. The present, general plant layout, shown in Chart 1, is based on the following considerations:

Space Requirements for each activity: Based on the space requirements, block dimensions for each of the shops were developed to ensure adequate flexibility in installation of equipment, for the insertion and support of large workpieces and efficient operator functioning.

Proximity for material flow: In view of the large amounts of material moving through the plant, material flow considerations were used to develop the relationships between facilities. The heavy machine shop was combined with the assembly shop to ensure proximity and the other facilities were placed around this combination resulting in a matrix-type flow.

Supporting Service Relationships: Supporting services were placed in relation to the primary facilities that would use them. The open stock areas were positioned adjacent to the fabrication shop and the forge and foundry where most production would be initiated. Administration and accommodation areas have been planned away from the plant along with the recreation and medical care areas.

Investment Cost Optimization: While preserving the basic relationships, site-utilization by the various blocks took into account the natural conditions of the site. The piling requirements and costs vary significantly along the site ranging from zero at the base of the hills to around US$20 per square meter in the reclaimed areas. Accordingly the heavier facilities, the forge and foundry and the heavy machine and assembly shops were positioned on firmer soil to reduce piling and foundation costs.

Wind Direction: The forge and foundry shops were placed at the edge of the site to take account of prevailing winds which generally flow in a northerly direction and with this position, would carry any residual fumes away from the remainder of the plant and residential area.

Control and Future Potential: The block-concept with separate blocks as against one or two massive structures will facilitate control of production activities. In addition, it permits the provision of adequate space around and adjacent to the blocks for systematic future expansion. Organization by functional blocks is considered appropriate for the production volumes proposed in the Project.

4. Conclusion: The layout of machinery and equipment within each facility is being finalized. Both plant site and general plant layout are considered appropriate and satisfactory for the operation of the plant.

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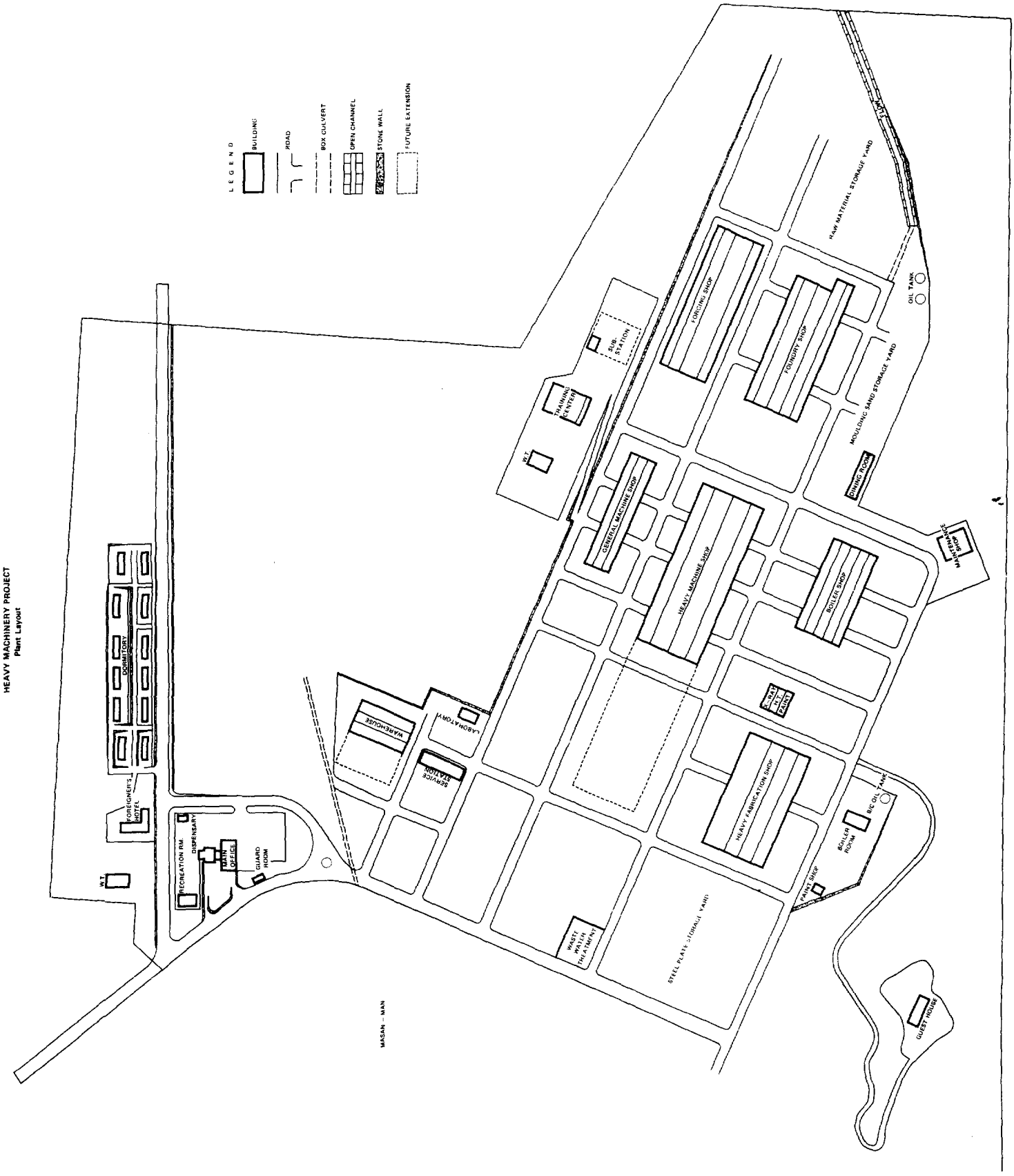
ANNEX 4-2
Chart 1



Industrial Projects Department

KOREA

HEAVY MACHINERY PROJECT

TECHNOLOGY

A. Introduction

1. The products planned for manufacture under the Project are primarily technology and material intensive. The products represent a technology, both product and manufacturing, largely new to Korea. The products generally form parts of whole systems such as power-generation and steel-making systems, wherein overall reliability and built-in quality assurance is a critical consideration. Successful manufacture of these products would represent an upgrading of the Korean technological base into precision heavy manufacturing specially in forge, foundry and heavy machining activities. The products also utilize currently available technologies especially in the manufacture of small-dimension parts and components. For these, the Project would rely on existing facilities in the Changwon Complex and elsewhere in Korea. This factor has been incorporated in the design of the Project.

2. The Project involves a high level of technology transfer to be carried out under a number of licensing agreements with international manufacturers. Its successful implementation is dependent not only on suitable licensing agreements but also on adequate transfer of operating know-how and the availability of the required skills within HII. This can be accomplished through licensor contact, licensor and company training and the use of experienced expatriate personnel, where necessary.

B. Licensing Agreements

3. The requirements imposed on HII in the process of seeking licenses are unique for the following reasons:

(i) The level of technical complexity in most of the products is high at both engineering and manufacturing stages;

(ii) A number of different products and technologies are involved. HII plans to conclude nine major licenses and more than thirty licenses for auxiliary products;

(iii) All the licenses will be operative under one roof, many of them simultaneously, with common facilities being used for each while each licensor will have his own specialized engineering and manufacturing approach; and

(iv) It may not be possible to evolve licenses under similar terms in view of the licensors' varying origin, experience and background.

4. HII currently operates a number of international licenses for small and medium-sized products at its Gunpo and Anyang plants (see Annex 2-5). HII is in the process of negotiating agreements for products planned for manufacture under the Project and has so far concluded seven licenses for its primary products, selecting licensors, who are amongst the leaders in their fields.

	Product	Licensor	Term
(i)	Steel mill equipment:		
	Rolling Mills 1/	Wean United (USA)	10 years
	Iron and steel-making	Krupp (Germany)	5 years
(ii)	Power-generation equipment:		
	Turbo Generating Sets	General Electric (USA)	15 years
	Boilers	Combustion Engineering (USA)	12 years
	Water Turbine/Hydro Pumps	Creusot-Loire (France)	5 years
	Generator for Hydro Turbines	Alsthom-Atlantique (France)	8 years
(iii)	Chemical/Petrochemical equipment:		
	Fabricated equipment	Mitsubishi (Japan)	4 years

1/ Manufacturing Association Agreement

Licenses in Korea are generally granted for a term of 3 years; longer terms require detailed justification by the licensee. In light of the nature of the equipment, HII has been granted approval for longer terms especially on its licenses with General Electric and Combustion Engineering and agreement with Wean United. The other two licenses provide for further extension upon Government approval. The Company has also agreed with other international corporations for other products to be manufactured in order to level capacity utilization in the wake of the cyclical production requirements for the primary products. These secondary products include mining and pollution-control equipment. In addition HII is seeking to supplement these existing agreements with a number of others to cover the full range of products comprising the primary systems. For a review of the current status of HII's efforts see Table 1.

1. Transfer of Technology

5. Under the large number of license agreements, the transfer of technology aspect will cover the transmittal of existing documents, design data, manufacturing drawings, process sheets and parts and materials lists in accordance with the licensors' practices. In each case HII would be required to adapt the information to its own system and environment. For this purpose, the Company plans to establish within its technical organization (see Chart 1), a competent Engineering Cell. A flexible general design

capability is planned, constituting an engineering manpower resource. Over this general capability design specialists will be required for each major product group. The number of groups (shown as 'A' and 'B' in Chart 1) would depend on the number of product-groups manufactured. Each would be the responsibility of a Product Design Manager, specializing and concentrating on his specific product group, who would draw resources from the engineering cell, as necessary. Also responsible to the Director of Engineering would be the Manager of Standards and Services, responsible for maintaining, and integrating where possible, the multiple engineering standards used by the licensors. He would also ensure that bought-out components conform to the required standards.

6. Director of Technology Transfer: In view of the complexities involved in the transfer process, HII plans to establish a special position, titled the Director of Technology Transfer, reporting directly to the Executive Director for the Project (Chart 1). He would be responsible for managing the interface between the Company and existing and potential licensors. The interface with licensors can be divided ito three general categories:

(i) Evaluation of market requirements to identify potential products and negotiation of suitable agreements for these products;

(ii) Joint HII and licensor sales activities; and

(iii) Licensor assistance in implementation of a manufacturing capability as well as of specific contract orders.

These will involve HII staff from most departments and will occur in Korea and at licensor plants. The Director of Technology Transfer will be responsible for coordinating these interactions. The latter two categories are especially important as these relate to a critical aspect of HII's strategy. In order to ensure acceptance of the market, HII plans to bid its initial contracts with the licensors, with a joint performance-guarantee. As its products gain acceptance and the Company establishes a reputation for reliability, it will undertake total manufacture and performance guarantees on its own.

7. In these interactions, the Director of Technology Transfer will play a key role. His responsibilities will extend to the early stages of each license:

(i) Identifying with the potential licensors, the appropriate products and technologies in line with the requirements of HII's major customers;

(ii) Developing and negotiating the details of the agreements to provide for the required flow of technology, assistance and training; and

(iii) Coordinating the flow of information and personnel between HII and licensor facilities to ensure implementation of the technology.

In the later stages, the responsibility for continuing functions would shift to other HII directors. The functions outlined above are crucial to the success of the Project and HII's approach is considered suitable.

2. Training

8. The license agreements also provide, to a varying degree, for the training of HII staff at the licensors' facilities. HII plans to fully explore the training opportunities provided by the licenses and extend them, if required. The Company plans to adopt a three-fold approach to the overseas training of its staff at licensor and equipment-supplier facilities (for details see Annex 4-7):

(i) Product-oriented programs to give in-depth product experience and a broad understanding of the total manufacturing functions within each licensor, for its engineering staff;

(ii) Manufacturing and specialized activity programs to give in-depth experience relating to the manufacturing techniques and related activities used in the licensor plants on a multi-product basis for managers, engineers, supervisors and key operators; and

(iii) Operating activity programs at the facilities of suppliers of key equipment for in-depth experience in operating key items of machinery.

C. Technical Assistance

9. All licensing agreements would cover technical assistance to HII from the licensor and such assistance is considered to be adequate in the areas of Machining, Assembly and Fabrication. Though a measure of assistance would be available in relation to the Forge and Foundry operations, the licensors such as General Electric have traditionally purchased their requirements of castings and forgings and would not be able to provide the appropriate exposure. In view of this fact HII would be required to essentially directly transfer operating know-how for these facilities which in turn would be linked to facility selection and layout. The Company has accordingly selected Terni (Italy), an experienced operating company and signed a consulting and technical assistance agreement for the provision of assistance in detailed engineering, implementation and operation of the foundry and forge shops in the early years.

D. Expatriate Requirements

10. The Company recognizes the importance of experienced staff in the initial stages of the Project and porposes to recruit expatriate staff to fill this need. Korean staff would be assigned as counterparts and the expatriates retained till the counterparts are able to take over their responsibilities which would include:

(i) Multi-product operation management; and

(ii) Product and manufacturing technology transfer.

The key expatriate appointee will be the Director of Engineering, supported by a counterpart who would take over his responsibilities after a fixed period of time. It is proposed to locate a person with a proven senior management track record in a multi-product/heavy engineering business, as early as possible so that he can contribute in preparing for the start-up of operations.

11. It is proposed that experienced expatriate staff, from the licensors' staff (if suitable arrangements can be worked out) or from similar facilities be appointed in line functions for the key product-groups. Their terms would last at least until the first major contracts in these groups are successfully executed, and the Korean counterparts are fully conversant with the requirements. Other appointments would include staff to undertake dual responsibility with Korean management for the positions of Director of Engineering, Machine-shop manager, Foundry and Forge Manager, Manager of Manufacturing Engineering and Forge Master. The Company plans to recruit at least 10 expatriate management-level staff and funds for this purpose have been included in the Project. In addition, it is anticipated that some staff at the operator and foreman levels providing assistance and training by example would be required. This matter is to be reviewed further in the detailed planning stage.

E. Benefits to Suppliers

12. Under the Project, HII would acquire substantial experience in the area of licensing and technology transfer. The Company plans to make this experience available to its suppliers and other producers. The Project would require a number of light and medium parts and components requiring sophisticated production techniques and new technologies. Project design excludes capacity in these areas. HII would offer seminars for interested producers to make them aware of the possibilities for supplying parts and components to the Project. It would indicate to these smaller manufacturers, suitable products for licensing for use in its own operation and otherwise in the Korean context. Thereafter it would assist these companies in selecting licensors and guide them in negotiating suitable arrangements. In addition, HII proposes to train operators of its suppliers on a cost basis to upgrade their manufacturing skills and product quality.

F. Conclusion

13. HII has already entered into a substantial number of licensing agreements for its existing operations at Gunpo and Anyang (see Annex 2-5) and has been able to operate them successfully. Though this experience is useful, the complexity of the products currently planned is far greater than that of existing operations. The scale of operations as well as HII's responsibility for overall product-reliability will also be far larger than for products manufactured at Gunpo and Anyang. The approach discussed above, while retaining some concepts from HII's experience, has been strengthened significantly to take account of these factors and is considered appropriate for successful implementation of the Project. The key elements discussed above such as training, technical assistance, expatriate appointments and assistance to suppliers would have to be developed in greater detail as additional licenses are signed and the final review by the consultants completed, to facilitate adequate transfer of technology.

Industrial Projects Department
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KOREA

HEAVY MACHINERY PROJECT

STATUS OF LICENSE AGREEMENTS FOR PROJECT

Products	Licenses		
	Agreed	Negotiating	Consideration and Preliminary Discussion
1. Iron and Steel Making Plant Machinery			
1.1 Iron Making (Sintering Plant, Coke Oven, Blast Furnace)	Krupp (Germany) 3/25/77		
1.2 Steel Making	Krupp (Germany) 3/25/77		
1.3 Lime Calcining			Krupp (Germany); Voest Alpine (Austria)
1.4 Continuous Casting		Demag (Germany)	Krupp (Germany); Voest Alpine (Austria)
1.5 Rolling Mills (Blooming/Slab, Plate, Hot/Cold Strip, Section Mills)	Wean United[1/] (U.S.A.) 2/13/76	Wean United (U.S.A.)	Demag (Germany); Mitsubishi (Japan); Davy Ashmore (U.K.)
2. Power Generating Plant Machinery			
2.1 Electric Power Generator Turbo-generator sets (Thermal Nuclear)	General Electric (U.S.A.) 7/26/76		
2.2 Boilers	Combustion Engineering (U.S.A.) 2/15/77		
2.3 Condensers		Hitachi (Japan)	Ingersoll Rand (U.S.A.); Allis-Chalmers (U.S.A.)
2.4 Boiler Feed, Pumps/Systems			Hitachi (Japan); Ingersoll Rand (U.S.A.); Weir Pump (U.K.)
2.5 Water Turbine	Creusot-Loire (France) 11/30/76		Allis-Chalmers (U.S.A.); Hitachi (Japan)
2.6 Hydro Pumps	Creusot-Loire (France) 11/30/76		Hitachi (Japan)
2.7 Hydro Generators	Alsthom-Atlantique (France) 2/19/77		
3. Chemical and Petrochemical Plant Equipment			
3.1 Fabricated Equipment (Reactors, Heat Exchangers, Vessels/Tanks, Columns/Towers	Mitsubishi (Japan) 5/7/76		
3.2 Pumps and Compressors		Demag (Germany)	Allis-Chalmers (U.S.A.); Ingersoll Rand (U.S.A.); Dresser Ind. (Germany); Creusot-Loire (France); Demag (Germany)
4. Auxiliary Products			
4.1 Large Presses	Osaka Kiko (Japan) 11/3/75 (up to 300 tons)	Kawasaki Yucoh (Japan)	
4.2 Heavy Cranes	P and H Dia (U.S.A.)		
4.3 Pollution Control Equipment	Fuller Co. (U.S.A.) 5/20/74 Hitachi (Japan), 10/28/76	Fuller Co. (U.S.A.) (Dust Collector)	
4.4 Non-ferrous metal making machinery	Wean United (U.S.A.) 2/13/76		Wean United (U.S.A.)
4.5 Large Hydro Valve			
4.6 Mining Equipment	Fuller Co. (U.S.A.) 5/20/74 Jaques Ltd. (Australia) (Crushing equipment) 1/14/76		Allis-Chalmers (U.S.A.); Hitachi (Japan)
4.7 Sewage Treatment			Hitachi (Japan)
4.8 Oxygen Generation		Air Products (U.K.)	Demag (Germany); Davy International (U.K.)
4.9 Desalination			Demag (Germany); Weir-West-Garth (U.K.)

1/ Manufacturing Association Agreement

Industrial Projects Department
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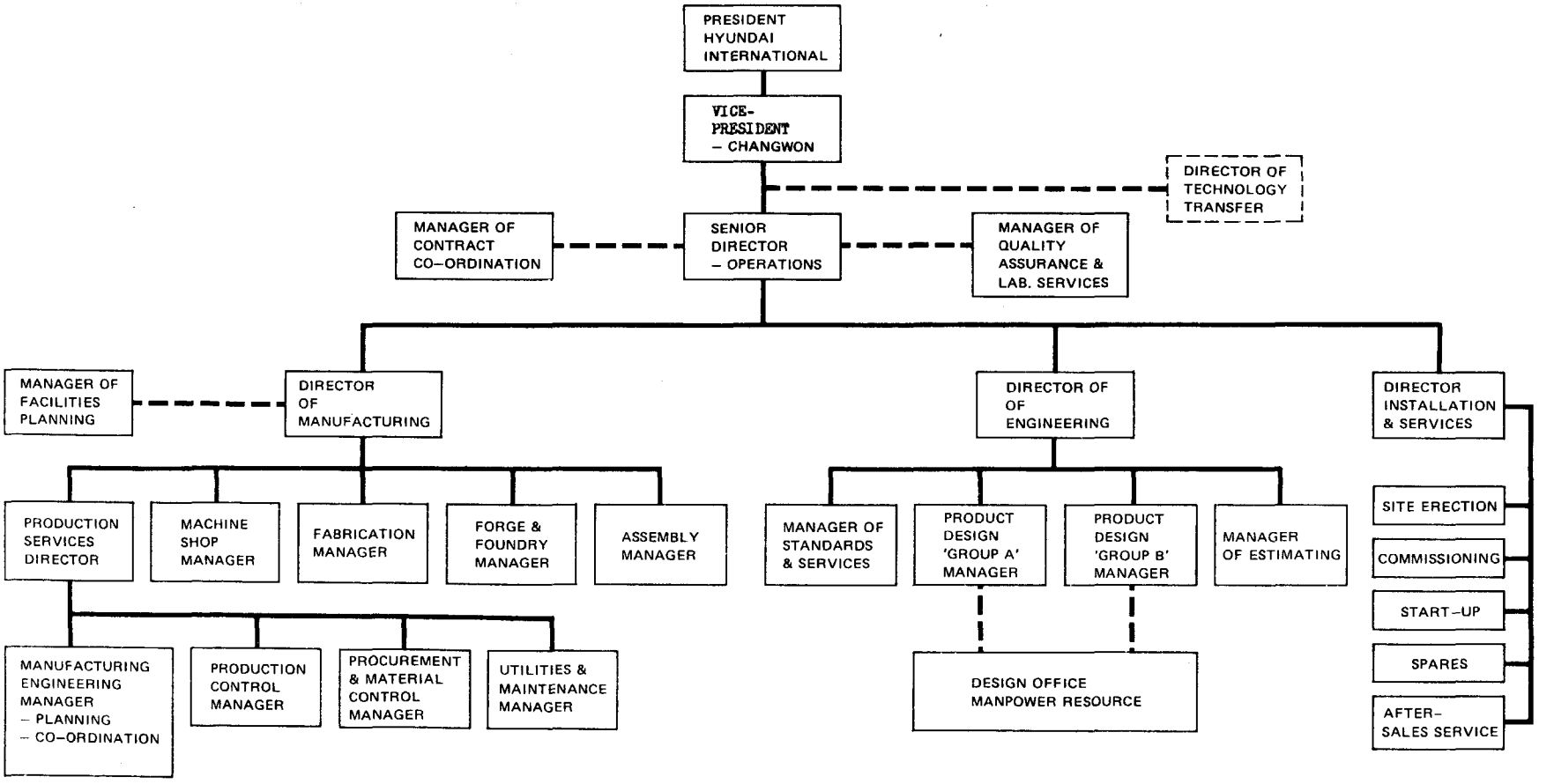
KOREA
HEAVY MACHINERY PROJECT
Technical Organization



Industrial Projects Department
January 1977

World Bank–16803

ANNEX 4-3
Chart 1

KOREA

HEAVY MACHINERY PROJECT

PROCESS FLOW

A. Classification of Products

1. The primary products planned for manufacture at the Heavy Machinery Project fall into two distinct categories from a manufacturing point of view:

1. Those which are predominantly machined and assembled; and

2. Those which are predominantly fabricated.

There is an interface between these two categories for some products such as generators but the categories serve adequately as a basis for discussing the process-flow in the plant. The primary products impose a cyclical load on the plant and therefore other products are planned for manufacture in order to operate the plant at full capacity. These products would fall in either of the above categories depending on the availability of capacity.

1. Machined Parts

2. Large parts that are predominatly machined include the following:

(i) Steel-Mill Equipment: Roll-stand, Rolls, Universal Shaft, Trunion Shaft for Basic Oxygen Furnace etc.

(ii) Power-Generation Equipment: High pressure Turbine Casing, Rotor Shaft etc.

(iii) Chemical/Petrochemical Equipment: Flange, Pump and Compressor Casings, Impeller etc.

These parts can be further divided into cubic parts, which are mainly castings and cylindrical parts, which are primarily forged.

3. A typical process flow for such products is shown in Chart 1. Some of the operations shown take place concurrently. The three primary lines of flow can be illustrated using turbine and turbine generator components as examples.

Step 1: The low pressure cylinder outer-casing for the turbine comes through the fabrication shop where the plate is cut, prepared and welded (processes covered under Fabricated Components). The high-pressure shell is cast and the generator rotor is forged from an ingot. At this stage each component is tested (not shown on chart) for cracks and other defects.

Step 2: The fabricated outer-casing is taken through the stress-relief facility and the high-pressure shell and rotor are heat-treated in the common facility. At this stage there are stringent quality-control checks using X-ray techniques and thorough proof-machining of the castings to check for porosity and blow-holes etc.

Step 3: All components are transferred to the heavy machine shop. The flat surfaces of the outer casing and the high pressure shell are prepared on the adjustable-rail milling machine. The rotor is first rough-turned and then machined on the rail-milling machine. This sequence of operations would take around 2 months.

Step 4: At this stage the components are put through more complex and final machining operations in the heavy machine shop. The low-pressure outer casing is drilled and then finished on the line bar machine. The high-pressure shell usually of chromium-molybdenum-vanadium alloy steels, weighing between 40 and 70 tons requires special tools and a longer sequence of: drilling; line-bar machining; adjustable rail milling; horizontal boring; and drilling. Quality control inspection is implemented at each stage.

Step 5: Before transfer to the assembly area each part is thoroughly inspected for finish and tolerances which are very stringent given the nature of the product. At this stage all other components, separately bought or prepared such as bearings, valve bodies, gears and sprockets are also inspected.

Step 6: In the sub-assembly stage, the components are assembled where necessary and practical. The smaller parts such as the turbine diaphragms assembled onto the casing, the coil windings and cooling tubes onto the generator-rotor and the gear-assemblies put together. Each sub-assembly is tested separately, where essential in operation, such as in the concrete test-bunker for generator-testing provided in the shop. Primer painting is also done at this stage.

Step 7: In the final stage the components are finally assembled, tested for compatibility etc. and final modifications made. Thereafter, the product is prepared for shipping in modules convenient for transportation, after painting in line with customer requirements, and packed in the packing facility included in the shop.

2. Fabricated Products

4. Large fabricated parts, primarily very heavy pieces and those built-up from very thick plates include:

(i) Steel Mill Equipment: Blast Furnace, Basic Oxygen Furnace, Mixer, Ladle and Drum Mixer.

(ii) Power-Generation Equipment: Boilers, Condensers, Generator Casing and Turbine Casing for the Low Pressure Cylinder.

(iii) Chemical/Petrochemical Equipment: Heat exchangers, Reaction and Pressure vessels.

These parts can be further divided into three categories depending on the input materials, tubes, section-steels and steel plates.

5. A typical process flow for such products is shown in Chart 2 and the lines of flow on the fabrication end can be illustrated using the flow for boiler manufacture. The sequence of activities shown could take up to 9 months.

Step 1: The materials in the form of tubes, section-steels as steel-plates are pre-heated for marking and cutting. The pre-treatment process comprises a range of surface-preparation operations such as shot-blasting, depending upon the state of the incoming materials.

Step 2: The tubes, plates and section-steels are then marked and cut to required shape and size on plate-burning tables using a range of gas-cutting equipment and plasma-arc cutting machines.

Step 3: The tubes are taken for expansion where necessary. Generally the tubes, the section-steels and the drum-plate are prepared for welding and welded using different technologies such as Arc, Submerged Arc, TIG, MIG and electroslag-welding under precisely controlled conditions.

Step 4: The welded items are heat-treated in order to relieve the special stresses generated during the preceding operation, in order to preserve material texture and to increase joint efficiency.

Step 5: Machining and like operations follow where the edges of the tubes are finished and prepared, the edges of the sections and drum are beveled. There is a full range of drilling equipment provided in the shop for suitable operations on the drum-vessel and the end-plate.

Step 6: At this stage the components are all individually inspected for quality, strength and against required dimensions.

Step 7: The boiler-drum and the end-plates are welded together in a sub-assembly operation which again necessitates a stress-relief phase.

Step 8: The components are coated, with rust-preventing primer and other paints according to customer requirements and then put through a stringent test-phase.

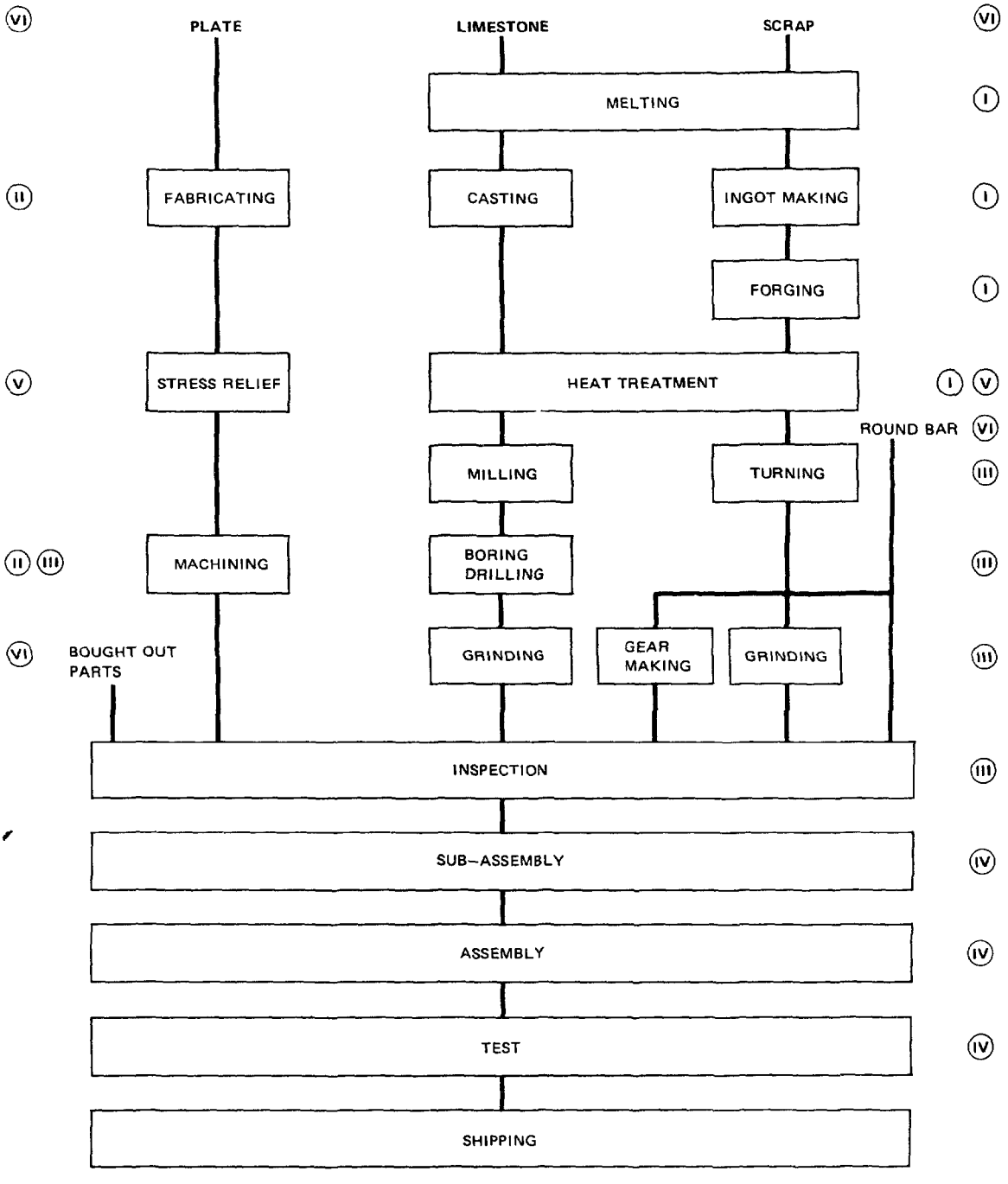
Step 9: Final assembly is carried out incorporating the above components, bought-out items and others flowing in from the machine shop and parts-warehouse. Thereafter, the product is finish-painted, finally tested and prepared for shipping.

6. The equipment for steel-mills, the blast-furnace, the mixer and the ladle essentially follow a similar course.

B. General Considerations

7. Though the above process-flows describe the general route followed by the product components, each job would be routed in accordance with the availability of machines. A great deal of versatility is incorporated into the Project and more than one machine can generally be used for a particular operation. The Company is planning to prepare process charts for each product in accordance with licensor-furnished manufacturing drawings and their own equipment configurations. Production-planning based on process-charts adapted to the HII system will be critical to the Project, reflected in HII's program to build up strong in-house manufacturing and production engineering capabilities.

KOREA
HEAVY MACHINERY PROJECT
PROCESS FLOW OF MACHINED PRODUCTS
Applicable to Major Products like Turbine–Generators, Rolling Mills, Pumps, Compressors



Legend
(I) Foundry/Forge Shop
(II) Fabricating Shop
(III) Machine Shop
(IV) Ass'y/Test Shop
(V) Heat Treatment Shop
(VI) Purchase from Outside

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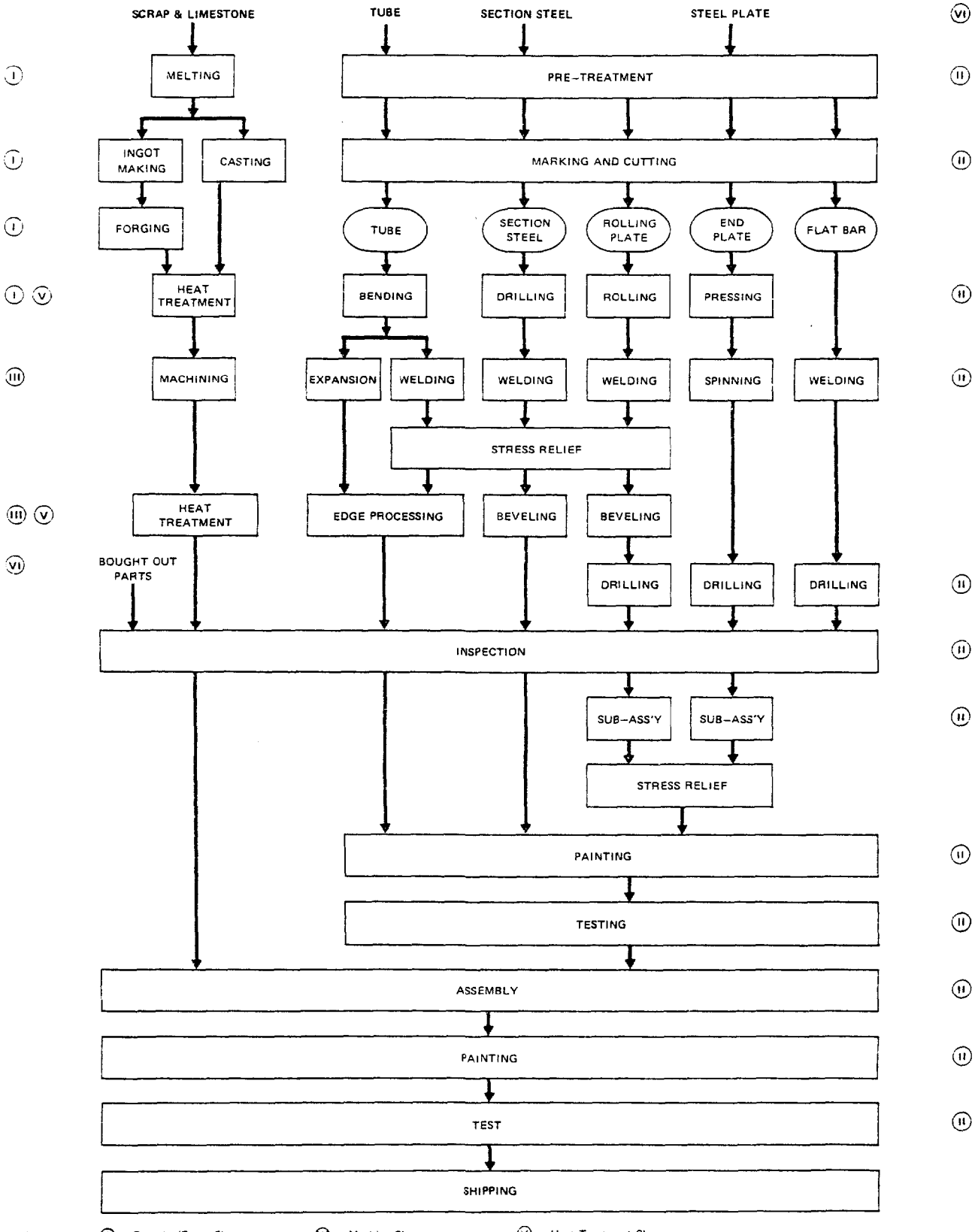
KOREA
HEAVY MACHINERY PROJECT
PROCESS FLOW FOR FABRICATED PRODUCTS
Applicable To Major Products Like; Boiler, Heat Exchanger, Tower, Reactor, Vessels, Bof, Blast Furnace



LEGEND:
- (I) Foundry/Forge Shop
- (II) Fabricating Shop
- (III) Machine Shop
- (IV) Assembly/Test Shop
- (V) Heat Treatment Shop
- (VI) Purchase from outside

Industrial Projects Department

KOREA

HEAVY MACHINERY PROJECT

RAW MATERIALS AND COMPONENTS

A. Introduction

1. The products scheduled for manufacture at the Heavy Machinery Project are largely material-intensive. The value of the total requirements of materials and bought-out parts and components is estimated at 54% of sales value at the steady operational state in 1983. The requirements will be much higher in early years, amounting to 78% of sales value at start-up and gradually declining to the 1982 figure. The material inputs can primarily be segmented into: iron, ferro-alloy and scrap requirements for castings and forgings; and plate, pipes and tubes for fabrication work. The Project would also require a range of bought-out parts and components to be procured locally and overseas. The general approach would be to import the technically complex parts, and locally purchase parts for which the technology is available in Korea. The proposed estimates are based upon detailed data for representative products in each product-group, developed from information supplied by licensors. A summary presentation of the Project requirements and supply sources is shown in Chart 1.

B. Material Requirements

1. Raw Materials

2. The planned end-product tonnage in 1983 amounts to 100,000 tons and can be classified into predominantly machined and predominantly fabricated products (see Annex 4-4). The primary inputs for first group are high-grade forgings and castings from the Project's forge and foundry shops. Plates, pipes, tubes, bars and shapes would form the raw materials for the fabricated items. These input requirements are summarized in the table below.

HII: Material Requirements (1983)
Unit: 000 tons

Product Group	Output			Material Input					
	Machined	Fabric.	Total	Casting 1/	Forging 1/	Plate	Pipe& Tube	Other	Total
Steel-Mill	11.1	16.2	27.3	15.3	8.3	9.5	0.4	0.5	34.0
Power-Generation	3.4	11.6	15.0	2.0	0.6	6.2	9.5	-	18.3
Chemical/ Petrochmical	2.5	19.4	21.9	1.5	4.7	12.8	6.6	1.1	26.7
Sub-total	17.0	47.2	64.2	18.8	13.6	28.5	16.5	1.6	79.0
Ancilliaries	6.3	12.2	18.5	5.2	3.9	8.7	5.1	0.5	23.4
Jobbing	10.3	7.0	17.3	8.3	4.6	6.2	3.0	0.3	22.4
Total	33.6	66.4	100.0	32.4	22.0	43.4	24.5	2.4	124.8

1/ Represents the tonnage of the cast and forged items; primary metal requirements would be higher due to process losses.

3. The Company has assessed the local availability of the above materials and it is expected that the majority of the requirements could be obtained locally. The supply capabilities of local producers are shown in Table 1. The scrap requirements for the foundry would be adequately available from internal generation and from the Hyndai shipyard. HII plans to issue early enquiries for small quantities of the basic requirements so that tests can be performed in laboratories in Korea or where necessary in the facilities of the licensors. Until the quality is established, HII would import limited quantities to meet its requirements, simultaneously encouraging the development of local industry. Special items such as magnetic steels and extra-thick plates would continue to be imported beyond 1983 until domestic capability is extended to these areas.

2. Parts, Components and Supplies

4. The Company will purchase a variety of parts and components for use in production, such as controls, electrical systems, light castings, forgings and machined products. At the steady state of operations, in 1983. the Project's proposed production would require a purchase of US$73 million equivalent of local and imported parts and components as shown below.

HII: Parts and Components Requirements (1983)
(US$ million)

Product Group	Output	Parts and Component Input (% of Output)					
		Local	(%)	Import	(%)	Total	(%)
Steel-Mill	76.9	9.1	(12)	6.5	(8)	15.6	(20)
Power-generation	159.6	11.5	(7)	25.0	(16)	36.5	(23)
Chemical/Petrochemical	80.0	8.1	(10)	8.9	(11)	17.0	(21)
Sub-total	316.5	28.7	(9)	40.4	(13)	69.1	(22)
Ancillaries	47.5	-		2.3	(5)	2.3	(5)
Jobbing	32.0	2.5	(8)	-		2.5	(8)
Total	396.0	31.2	(8)	42.7	(11)	73.9	(19)

5. The make-buy philosophy underlying the above requrements covers two aspects. Firstly the Company plans to import on a continuing basis, components that involve a specialized technology and manufacturing process wherein investment is not justified in view of the Project's limited requirements. These will include items such as governing and control equipment with hydraulic systems,

solenoid operated high pressure valves and the turbine blades for the last few stages. Secondly, HII plans to utilize the existing technology base in Korea as far as possible by subcontracting for locally available items wherever that is feasible without any risk to production planning and quality. For example the required light machine capacity has been reduced in the Project to permit utilization of existing Korean facilities. In this regard, the Company plans to encourage the development of local manufacturers by indicating products suitable for manufacture and through assistance in obtaining license agreements, and in the training of supplier staff.

6. Consumable supplies would largely be locally purchased from an adequate existing supply capability. Existing Korean companies would be in a position to furnish the requirements for refractory, sand additives and a major proportion of welding electrodes, insulation supplies and paints and varnishes. Some special electrodes and insulation-related supplies would be imported. The requirements for lubricants, cutting oils, cutting and heat-treatment gases would also be supplied locally and are covered in Annex 4.8, Infrastructure.

D. Localization

7. The schedule of material and parts and component requirements indicated above is built up through a pattern of increasing localization between start-up in 1978 and steady operations in 1983. In the start-up

phase, the Company would directly purchase a number of major components in finished and semi-finished form from the licensors and their recommended suppliers. For example, turbine generator rotors and turbine blades that are planned for manufacture in 1983 would be imported in the early years. The Company would build up from a largely assembly-type operation in 1978 to a full manufacturing operation in 1983. For a list of major turbine-generator components to be imported in the early stages, see Table 2. This pattern is reflected in the material breakdown and cost data (Annex 7-3) where imported bought-out parts are increasingly replaced by raw materials for in-plant manufacture and by locally purchased parts. The planned approach is considered satisfactory in that it would ensure product quality in early years and would also be most acceptable to licensors, who are expected to provide joint performance guarantees on initial contracts.

E. Sources of Supply

8. The raw material and component requirements will be supplied from various sources as shown in Chart 1. HII's existing facilities at Gunpo and Anyang will be in a position to furnish part of the requirements of light components and some simple electrical assemblies. Manufacturing concerns in the Changwon Complex itself are capable of supplying a large part of the requirements of basic mechanical and electrical engineering items such as motors, instruments, tools, gears, bearings, springs and fasteners. The Korea Integrated Special Steel Company, which is presently under construction in the Complex, is expected to supply part of the stainless steel requirements. The major proportion of the primary raw material requirements are expected to be supplied from other sources in Korea. These primarily comprise the national steel company, Pohang Iron and Steel Company (POSCO), and a number of smaller producers such as Dong Kuk Steel and the Korea Ferro Alloy Company. POSCO, expected to be the largest supplier, is also located on the coast around 150 miles from the Project site. As discussed, the imports will largely be obtained through the licensors and their recommended suppliers in their respective countries. This will ensure compliance with licensor specifications and minimize production problems.

F. Conclusion

9. The Company's planned approach with regard to its make-buy policies and its reliance on local industry as far as possible is considered satisfactory. It would also assist in the development of supply industries to the Project. However, as indicated, localization would only proceed at a gradual pace and reach around 85% of production cost by 1983 if product quality is to be assured. Any Government measures to accelerate the pace of localization of the planned products could have negative consequences.

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KOREA

HEAVY MACHINERY PROJECT

SUPPLY CAPABALITY OF RAW MATERIALS AND COMPONENTS IN KOREA

1. Materials

Unit: mm

Item		Specification min.	Specification Max.	
Pig Iron				
Foundry	C	3.4%		POSCO
	Si	1.5%	2.5%	
Ferro Alloy				
Fe-Si	Si	40.0%	99.8%	Sam Chok Inc.
Fe-Mn	Mn	73.0%	82.0%	Korea Ferro Alloy
Si-Mn	Si	60.0%	78.0%	Inchon Ferro Alloy
	Mn	14.0%	25.0%	
Scrap	-	-	-	In-plant generation Hyundai Shipyard
Flat Steel				
Plate	Dimensions	4.5 x 915 x 1,830	200 x 3,100 x 22,000	POSCO Dong Kuk Steel
H.R. Sheet	"	1.2 x 520 x 1,500	6.4 x 1,240 x 6,100	POSCO
C.R. Sheet	"	0.18 x 65 x 914	3.5 x 1,240 x 6,100	Union Steel, Ilsin Steel POSCO
Skelp & Hoop	"	0.18 x 65	3.2 x 1,240	POSCO
Tin Plate	"	0.18 x 710 x 508	0.37 x 914 x 1,117)	POSCO, Ilsin Steel,
Galv. Plate	"	0.2 x 610 x 914	1.2 x 1,000 x 3,657)	Union Steel, Dong Yang Tin Plate
Electrical Si Plate	Thickness	0.35	0.5	Inchon Iron & Steel
Stainless & Sheet	Dimensions	0.3 x 50	3 x 1,000 x 40,000	Korea Integrated Special Steel
Non-Flat Steel				
Deformed Bar	Diameter	9	41	Dong Kuk Steel, Inchon Iron & Steel, Kang Won Steel, Kuk Dong Steel
Round Bar	"	6	130	
Square Bar	Square	12	30	Dong Kuk Steel
Flat Bar	Dimensions	3 x 25	9 x 75	Inchon Iron & Steel
Channel	"	75 x 40 x 5	200 x 90 x 8	Inchon Iron & Steel
H-Beam	"		250 x 125 x 9	Dong Kuk Steel, Ilsin Steel
Angle	"	3 x 19	15 x 150	Dong Kuk Steel, Inchon Iron & Steel, Kang Won Steel, Kuk Dong Steel
Lip Channel	"	1.6 x 60 x 30 x 10	4.5 x 250 x 80 x 20	Union Steel
Wire Rod	Diameter	5.5	25	Dong Kuk Steel, Kuk Dong Steel, Inchon Iron & Steel
Light Rail	Weight	9 Kg	22 Kg	Inchon Iron & Steel
Stainless Steel Bar	Diameter	5.5	300	Korea Integrated Special Steel
Steel Pipe				
Welded & Spiral Steel Pipe	Diameter	6	350	Kia Ind., Korea Steel Pipe, Kong Sue Steel, Dong Yang Pipe
Casting Pipe		400	2,400	Korea Cast Iron Pipe

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[illegible]

KOREA

HEAVY MACHINERY PROJECT

TURBINE-GENERATOR COMPONENT IMPORTS

	Turbine	Imported in Early Stages		Generator
		Turbine	Generator	
1.	H.P. Outer Casing	x	x	Stator Frame
2.	H.P. Inner Casing	x		Stator Punchings
3.	L.P. Inner Shell		x	Rotor Shaft
4.	Rotor Shaft	x	x	Retaining Ring
5.	Diaphragm	x	x	Stator Bar
6.	Governor Pedestal		x	Lead Box
7.	Nozzle Box	x		Bracket
8.	Turning Gear Housing			
9.	Turning Gear	x		
10.	Exhaust Hood			
11.	Buckets	x		
12.	Journal and Thrust Bearings	x		
13.	Cross-over	x		
14.	Expansion Joints	x		
15.	Oil Tanks			

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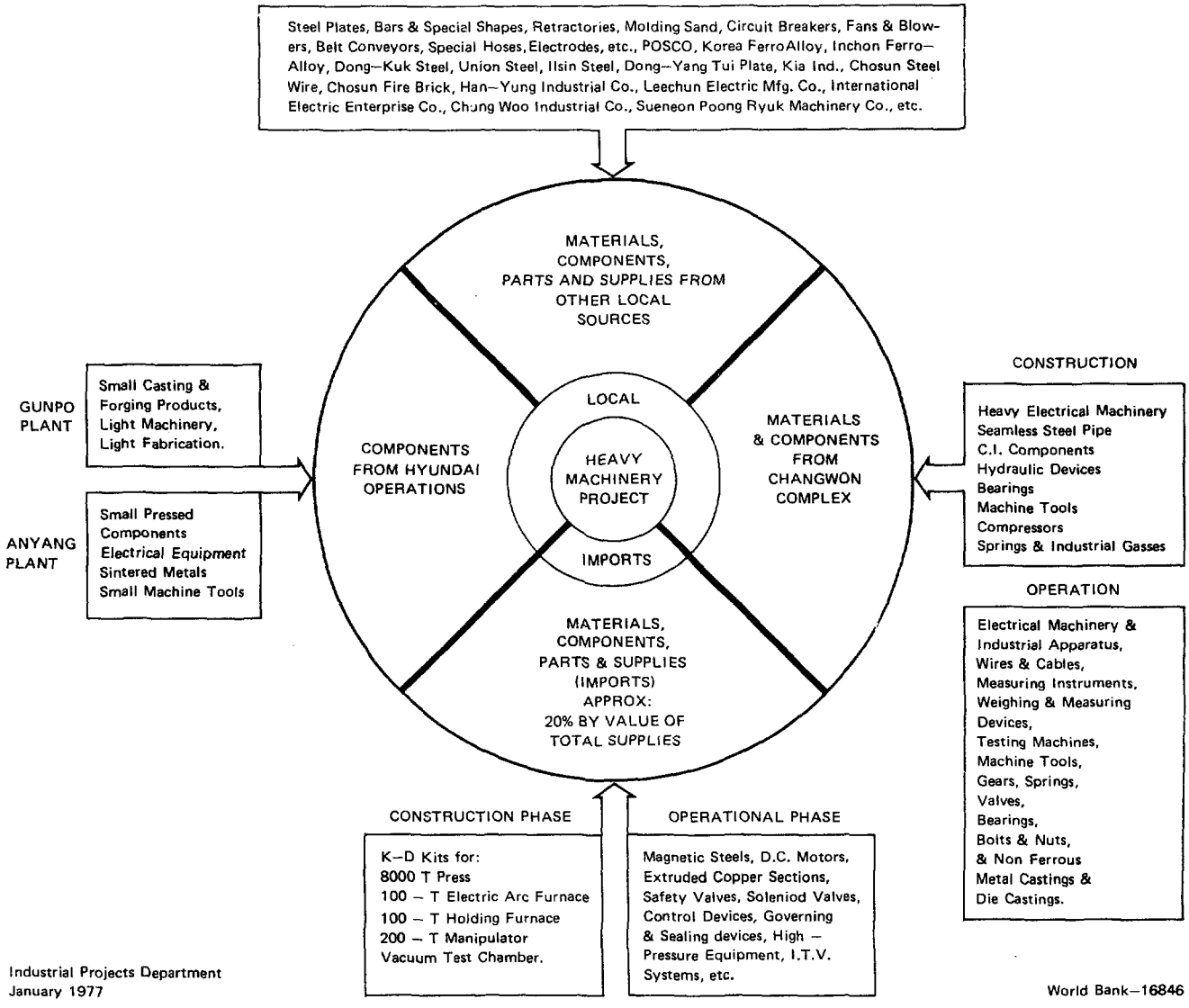
KOREA
HEAVY MACHINERY PROJECT
Chart: Raw Materials & Components Sources of Supply



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January 1977

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KOREA

HEAVY MACHINERY PROJECT

ECOLOGY

A. General Standards and Conditions in Korea

1. According to the Korean law, "Law on Prevention of Public Nuisance", as promulgated in November 1963 and amended in January 1971, it is necessary for all industrial enterprises to conform to the provisions of the law, which is mainly based on the practice followed in Japan; the standards appear to be stringent and close to international codes. The provisions in this law cover pollution by air, gases and particle emissions, by liquid or solid waste, and by noise levels and odors. The law also stipulates that the enterprises will have to obtain the necessary approval from the Ministry of Health and Social Affairs, with respect to pollution control facilities and its compliance with the said law. A summary of the minimum pollution standards set by the law is given in Table 1.

2. The design of the project takes into account all the provisions of the law, and necessary preventive measures have been incorporated in the plant facilities. However, HII has not yet submitted its project to the Ministry of Health and Social Affairs for the latter's approval of the facilities. With the exception of foundry and forge shop, HII's production is a clean operation with no adverse effect on the environment. Nevertheless, HII has identified all areas where pollution control would be necessary, and the salient features of the proposed pollution control systems are explained below.

B. Air Pollution Systems

3. The main areas that require air pollution control systems are: foundry and forge shop (for dusts, fumes, sulphuric acid gases, nitrogen chemical components and iron particles); heat treatment and drying furnaces (for fumes, and sulphur and nitrogen chemical compounds from combustion gases); and sand blasting facilities (for dusts, iron particles and inorganic substances.) The location of the foundry and forge shop within the overall plant layout is selected with due consideration to the direction of wind flow to avoid any pollution within the plant site. In addition, for prevention of dust, fume and particle matter this shop will have a electro-static dust collector with a capacity of 8,000 Nm^3/min. The effluent discharge will have a 0.02 g/Nm^3 concentration. The electric arc furnaces will have individual "bag-filter" type dust collectors (2,000 Nm^3/min. capacity each) to directly absorb dusts and fumes at the top of the furnace. The concentration of discharged materials would be about 0.02 g/Nm^3. For the heat treatment and

drying furnaces as well as for shot-blasting, central multi-hood dust collectors to control the concentration of discharged materials to 0.02 g/Nm^3 will be installed. The cost of air pollution control devices for the project is estimated to cost around US$5 million.

C. Water Pollution Systems

4. The waste water can be segregated into four major categories: (a) waste water containing lubrication oil, cutting fluids and metallic particles from machinery areas; (b) waste water containing acid emulsion from boiler plants; (c) waste water containing paints, welding fluxes and inorganic particles from the fabrication shop; and (d) waste water from rest rooms. It has been proposed that each group will be treated separately before they are received in the final 600 m^3/day treatment plant, where the effluent will undergo chemical treatment (chemical precipitation and segregation of the heavy and toxic elements, automatic pH adjustment and neutralization of combined flow.) Sludge residue from the process would be dried by filter pressing to a moisture content of about 50% before disposal by trucks. The water will be discharged into the sea and will have a pH value of around 6 to 7 and harmful materials of about 10 ppm. Total cost of the water pollution system is estimated to be around US$1.0 million.

D. Noise Pollution Control

5. With respect to noise and vibration, HII has planned to use "rock wool" or other similar materials as anti-vibration mountings or pads to keep the noise level down to 40dBA. However, the noise levels may go up to 80dBA in certain areas, particularly in the heavy forging shop, occasionally and for short periods of time.

E. Safety and Health Considerations

6. The project includes necessary safety and occupational health considerations. Each equipment will have its own safety guards to protect workers. Proper ventilation and heating systems for each major facility would be included in the building. A fully equipped fire fighting service is scheduled to be commissioned by early 1978. A dispensary, with necessary facilities for minor operations, will also be located within the plant site. These functions will be under the control of the Personnel and Labor Affairs Department.

F. General Observations and Conclusions

7. The pollution controls and environmental protection plans included in the project are considered adequate to meet the existing Korean laws which are similar to those existing in industrialized

countries. Procedures for sampling and monitoring are also being included in the overall scheme. Finally, the Company plans to establish a green belt by planting trees around the plant site to act as an acoustic barrier for the local residents. This green belt will be capable of absorbing 50 to 70 tons of dust per year and will help to create an attractive working environment.

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ANNEX 4-6
Table 1

KOREA

HEAVY MACHINERY PROJECT

POLLUTION STANDARDS IN KOREA

Categories	Permissible Concentration in the General Area	Permissible Concentration at the Plant Outlet
I. Gases and Dust		
NH_3	Less than 1 ppm	Less than 600 ppm
CO	" " 20 ppm	" " 3,000 ppm
HCl	" " 0.1 ppm	" " 60 ppm
Cl_2	" " 0.02 ppm	" " 50 ppm
SO_2	" " 0.2 ppm	" " 3,000 ppm
NO_2	" " 0.5 ppm	" " 250 ppm
CS_2	" " 0.5 ppm	" " 120 ppm
HCHO	" " 0.1 ppm	" " 70 ppm
H_2S	" " 0.1 ppm	" " 30 ppm
Dust	5 mg/m^3	1 mg/m^3
II. Liquid Discharge		
pH value		5.8-8.6
COD		Less than 150 mg/l
BOD		" " 200 mg/l
Oil and Fats		" " 30 mg/l
Phenol		" " 2 mg/l
Temperature		" " 40°C

III. Noise Limits

Permissible in office buildings	40-50 db
Permissible in production area	50-90 db

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KOREA

HEAVY MACHINERY PROJECT

MANPOWER AND TRAINING

A. Manpower Needs

1. The direct manpower requirements for the Project for the steady state of operations, past 1983, have been assessed on the basis of the number of fixed facilities in each shop. The estimate has also been reviewed against licensor and other similar facility experience through a comparison of their production volumes with those proposed for the Project. The indirect manpower has been assessed against the support functions including maintenance and other production services, engineering and administration. The total needs are shown below.

HII: Manpower Needs 1983 (Number of Employees)

1.	Direct: Labor	4,570
2.	Indirect: Labor	1,110
	Works Engineers and Trained Staff	950
	Works Managers	160
	Administration (includes some Technical Staff)	990
	Sub-total	3,210
	Total Requirements	7,780

The overall ratio of 59% direct to 41% indirect manpower reflects the level of technology, required engineering support and the indirect labor support to the operators of complex high investment machinery.

B. Manpower Development Plan

2. Table 1 shows the build up of manpower over the start-up phase of the Project through the steady state. The build-up schedule takes into account the planned production activity levels in each year, time for training activities and the initial learning curve inefficiencies. The estimates include requirements for expatriate staff to be replaced by Korean staff as the latter are fully developed to assume the responsibilities of the various functions.

1. Recruitment

3. No problem is foreseen in recruiting adequate numbers of personnel for the Project, recognizing that, where necessary, the Company plans to supplement the existing capabilities of the recruits with additional training. The Project Construction activity will employ a force of 4,000 at its peak and average about 2,200 over the construction period. A number of the welders and equipment operators from this force would be absorbed into the Project. HII also has a useful source in its affiliated companies. HII itself, the Construction Company and the Hyundai shipyard have a proven track record of erection of complex projects and some of this would be pulled into the Project. The Gunpo plant and the Shipyard would also provide manufacturing experience, the shipyard especially being a prime source of fabrication technology know-how. Some operators and technicians are already being trained at Gunpo. The Company also plans to recruit some experienced personnel from other machinery works in Korea.

4. In addition HII plans to recruit graduating engineers from Korean universities and craftsmen from the existing technical school system. A total of 21 technical highschools with a strength of approximately 8,000 students, a third of whom graduate each year, are located within a 30 km radius of the Changwon Complex. The Government also plans to establish another technical school (1,260 students) and a vocational training center (400 persons) for master craftsmen and supervisors, in the Complex. The potential labor force in the Complex vicinity is estimated at around 450,000 and is considered adequate to support the requirements of the Complex (estimated at 85,000 in 1981), while meeting the needs of other employers in the area. The mix of these potential sources to be drawn into the Project in the early stages, when the Company's own training programs would not have been established, is shown in Table 2.

2. Training

5. The availability of a well-trained work force with a suitable balance of skills is critical to the success of the Project. HII is fully aware of this requirement and is planning a comprehensive training program. Korea has achieved excellent standards in basic technician and craftsmen training through its system of universities and 3-year technical high schools and training centers. HII recognizes the additional requirements imposed by the new technology, complex heavy products and stringent quality requirements of the Project and plans to supplement existing capabilities with Company training, both overseas and in Korea.

6. Overseas Training: HII together with its consultants and licensors has developed its overseas training plan into a format of ten general training programs at the licensors' facilities and at the facilities of suppliers of key equipment. The licensor-related programs, provided for the license agreements, fall into two categories, product-oriented and manufacturing and specialized activity-oriented programs, and are shown in Table 3.

7. The product-oriented programs are aimed at providing in-depth product experience and a broad understanding of the entire spectrum of manufacturing functions within each licensor. These programs will basically be for training engineers in the areas of manufacturing and design engineering, production planning and quality control. The trainee engineers will essentially visit the licensor facility for the allowed period and follow the entire manufacturing cycle each from his professional perspective.

8. The manufacturing and specialized activity programs complement the product programs in a matrix fashion, each covering one major manufacturing activity - machining, fabrication, casting/forging; manufacturing engineering, production control and procurement - across the operations of all licensors. These programs would train managers, shop engineers, supervisors and key operators in the activity across the operations of all licensors. The Company has also identified the need to supplement licensor training in forging/casting operations in view of the process-nature of the technology and the limited experience of some of the licensors. Accordingly, the Company plans to seek a know-how and assistance agreement with an experienced operating company and provide for such training therein.

9. In addition to the above programs, 70 operators of key equipment will also be trained at the facilities of the supplier with the purpose of achieving total familiarity with the item of equipment. The proposed approach to overseas training is expected to provide specialist know-how in products, manufacturing techniques and machine operations, making available a broad mix of experience adequate to deal with production and related problems.

10. Project Training: The starting point of domestic training of supervisors and operators will be the core team of engineers, supervisors and operators who return from overseas training. These trained personnel will develop the basic training programs to be established and operated at the Project. The Training center is planned as the first facility to be completed in the Project, scheduled to begin operations by January 1978.

11. Four training stages are planned for personnel to operate the high value equipment. These will be technical high school graduates with a minimum of three years general machine experience.

(i) Induction course comprising basic class-room training in machine and supporting functions and utilization techniques;

(ii) Programmed shop training requiring trainers to plan operations for specific components in parallel with actual planning and operations on the shop floor, which would then be observed by the trainees;

(iii) Machine operation training with less critical parts or test pieces on the shop floor; and

(iv) Apprenticeship or functioning as assistants to the machine operators till they are capable of operating the machine competently themselves.

Only the operators of critical machinery would undergo all four steps. It is planned that a broad range of operators and supervisors will undergo the first two steps. The detailed training schedule is yet to be finalized but it is expected to reach upto 300 general trainees and around 100 senior operators per year.

12. Another important form of training programmed into the Project is on-the-job training of Korean staff and management as they serve as counterparts to expatriates. Expatriate technicians and managers will be part of the Project till such time as the local staff have picked up the skills to assume their responsibilities. This approach will supplement overseas training for key managers and technicians.

13. The training schedule at the Project will also cater to the needs of interested HII parts suppliers. The Company will train supplier personnel on request in an effort to upgrade existing supply capabilities along with assisting suppliers in seeking overseas licenses (Annex 4-3, Technology).

C. Conclusion

14. HII's training program as planned is considered generally adequate. The overseas training program is scheduled to begin in 1977 and would be developed further as additional licenses are signed. On the domestic side training has already begun at Gunpo and the Project training facility is expected to be fully operational by January 1978. This proposed timing for the training programs is considered satisfactory and would facilitate start-up of operations.

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KOREA

HEAVY MACHINERY PROJECT

MANPOWER DEVELOPMENT

Manpower	1978	1979	1980	1981	1982	1983
Direct						
Direct Labor	1,990	2,520	3,430	3,800	4,390	4,570
Index 1/	44	55	75	83	96	100
Indirect						
Labor	420	540	740	870	1,060	1,110
Works Engineers and Trained Staff	650	710	840	870	930	950
Works Managers	120	130	150	150	160	160
Sub-total	1,190	1,380	1,730	1,890	2,150	2,220
Index 1/	54	62	78	85	97	100
Administration						
Staff	380	550	640	820	910	990
Total Manpower	3,560	4,450	5,800	6,510	7,450	7,780
Manpower Index 1/	46	57	75	84	96	100
Plant Sales Index 1/	28	37	55	70	91	100

1/ Based on 1983 = 100

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HEAVY MACHINERY PROJECT

RECRUITMENT PLAN FOR 1978

Labor	Require-ment	Gunpo & Anyang Plant	Group Companies	HII's Job Training Center	Construc-tion Staff	Techni-cal Schools	Other Companies	Area Labor Pool
Direct								
Foundry/Forge								
Skilled	60	25	-	-	-	-	35	-
Semi-Skilled/Unskilled	60	-	-	-	-	25	-	35
Fabrication								
Skilled	640	100	200	-	100	-	240	-
Semi-Skilled/Unskilled	660	-	-	150	150	150	160	50
Light Machine								
Skilled	75	10	30	-	-	-	35	-
Semi-Skilled/Unskilled	55	-	-	20	-	15	-	20
Heavy Machining								
Skilled	45	30	15	-	-	-	-	-
Semi-Skilled/Unskilled	45	-	-	20	-	15	-	10
Assembly/Test								
Skilled	190	30	50	-	30	-	80	-
Semi-Skilled/Unskilled	160	-	-	30	30	50	-	50
Sub-Total	1,990	195	295	220	310	255	550	165
Indirect								
Maintenance								
Skilled	85	30	25	-	-	-	30	-
Semi-Skilled/Unskilled	70	-	-	-	20	20	-	30
Other Indirect								
Skilled	185	30	50	-	50	-	55	-
Unskilled	80	-	-	-	20	20	10	30
Sub-Total	420	60	75	-	90	40	95	60
Total	2,410	255	370	220	400	295	645	225

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ANNEX 4-7
Table 2

ANNEX 4-7
Table 3

KOREA

HEAVY MACHINERY PROJECT

OVERSEAS TRAINING 1/

Product Oriented Programs

	Trainee Managers and Engineers (Number)		
Product-Group	1977	1978	Total
Turbine-Generators	17	5	22
Pump/Compressors	9	5	14
Rolling Mills	3	4	7
Iron/Steel Making Equipment	4	10	14
Boilers	11	-	11
Chemical/Petro-chemical Equipment	8	4	12
	52	28	80

Manufacturing Activity Programs

		Trainees (Number)		
		1977	1978	Total
Machining:	Managers	1	2	3
	Engineers	5	30	35
	Supervisors/Operators	5	20	25
Fabrication:	Managers	1	1	2
	Engineers	3	12	15
	Supervisors/Operators	2	8	10
Casting/ Forging:	Managers	2	2	4
	Engineers	3	51	54
	Supervisors/Operators	4	23	27
Specialized Activity: 2/	Managers	2	11	13
	Senior Engineers	2	60	62
	Total	30	220	250

1/ To be developed further beyond 1978 as additional licenses are negotiated.
2/ Includes Manufacturing Engineering (48), Production Control (19) and Procurements (8)

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KOREA

HEAVY MACHINERY PROJECT

INFRASTRUCTURE

A. Introduction

1. In order to ensure a smooth and rapid development of the machine industry in Korea, the Government has established a large-scale integrated machine industry complex at Changwon under the control of the Changwon Industrial Development Corporation (CIDA) -- (see Annex 3-1 for policies and constituent operations). The Heavy Machinery Project is situated on the perimeter of the complex in an area originally set aside as a permanent green-belt. The release of the green-belt for the Project under Presidential signature, signifies the importance attached to the Project by the Government. The Government has undertaken to provide the basic infrastructure needs of the complex including the social requirements such as housing, education and sports facilities. The Project would derive its basic requirements from those available for the complex.

B. Changwon Industrial Complex

2. The complex (Map IBRD 12645) covers a total area of 43.4 km^2 of which 22.4 km^2 has been planned as industrial area and 20.9 km^2 as residential area. Of the industrial area, plant sites encompass 12.6 km^2, the remainder being devoted to other uses and being preserved as a green-belt. A total of 49 enterprises are expected to begin operations by the end of 1978 in the machinery and related fields. The complex will eventually house 104 companies and provide for the basic infrastructure requirements of all facilities at full operation:

1. Water Supply

3. Rain water is taken from the Nakdong River and the design rate for abstraction has been set at 200,000 tons/day to account for ultimate requirements. The rain water transmission system comprises a 1,650 mm diameter buried rising main of mild-steel construction, a booster station at Junam and a 1,350 mm diameter rising main from Junam to the Bansong treatment plant, 7 km away. The treatment process includes: sedimentation with attendant dosing equipment for removal of solids; rapid gravity sand filters; disinfection by chlorine dosing; and pH control by lime dosing. Plant and machinery is scheduled for complete delivery by June 1977 to be commissioned in August under the responsibility of CIDA. The initial throughput would be 120,000 tons/day. The Project's process and potable water requirements have been taken into consideration in determining this throughput. These will be provided by a 600 mm diameter trunk main which has already been laid upto within 2 km of the Project site.

4. The complex includes a grid substation set up by the Korea Electric Company with an existing capacity of 400 MVA and a present loading of only 10%. The substation when fully developed will have a capacity of 800 MVA, adequate to meet the demands of the complex. An overhead 154 kV transmission system has already been installed from the substation to the harbor facility and runs 3 km from the site, and would be tapped for the Project.

3. Transportation

5. The complex has access to the well connected Korean highway network with a direct 50 m. wide distributor link to the Masan-Seoul Highway. The primary distributor is fed by a district distributor system of 30 m wide carriageways. The local distributors from this 30 m wide road are 25 m wide. The local distributor to the Project site would ultimately form a loop from the district distribution system in the form of a coastal road and a direct link to the central area of the complex. The road system has been designed for traffic loading upto 2.5 million tons/year with gradients being limited to 3.3%. The roads embody a conventional drainage system. Harbor facilities, ultimately 7 berths for 20,000 ton vessels lie adjacent to the complex and only 2 km from the site. The first berth is scheduled for completion by the end of 1977. The complex is also linked to Seoul and Pusan by a rail-road network, not planned for use under the Project.

4. Communications

6. The master plan for the Complex provides for a fully automatic telephone exchange facility which will provide a total of 4,000 lines and 50 telex circuits. All major cities are expected to be linked to the system by the end of 1978; 600 lines and subscriber trunk dialing Seoul-Masan is already available.

5. Social Facilities

7. The complex has allocated around 40% of the total area to residential and social purposes. The Korea Housing Corporation is participating actively and 400 apartments were constructed in 1975. A further 960 are under construction of which 616 have already been completed. All homes would be available for rent or purchase against a 60% down-payment, the balance to be paid over 15 years. Accommodation comprises 43 m^2, 50 m^2 and 60 m^2 apartments with all facilities. The total development program for staff and worker housing on the complex is scheduled for completion in 1981 and would provide complete facilities including shops, recreation facilities, hospital and churches for an estimated population of 300,000.

6. Sewage and Trade Effluent Treatment

8. Legislation recently introduced in Korea dictates that all domestic sewage and trade effluent discharges be treated to comply with specific conditions. Originally it was the intention of CIDA to provide treatment facilities within the complex. This service has been withdrawn and it will be incumbent upon the constituent companies to provide treatment facilities at the site

for all industrial and other wastes. Present arrangements for disposal of solid waste at Changwon are provided through the private sector. A number of companies, approved by CIDA provide a competitive service in this regard.

7. Fire-fighting

9. A fully equipped Fire Station is scheduled to be commissioned by June 1977 in the complex. The station is located in the center of the main complex adjacent to the main boulevard and would provide services to the residential area and strong back-up facilities for the individual services which must be provided at each individual site.

10. In addition to the above the Government proposes to set up a Machinery Development Institute in the complex at an initial cost of US$5 million. The Institute would serve as a Research and Development base for the constituent industries. Each enterprise in the complex is required to subscribe to the Institute making it a cooperative venture. In view of the scale of the complex when fully operational, the initial outlay is considered too low and it is expected that the Government would provide additional funds. The plans also include a Technical Training Center to be set up under CIDA by April 1977. An investment outlay of US$6.0 million has been provided for this purpose. The center would train craftsmen and supervisory personnel to feed the complex.

C. Infrastructure and Inter-plant Services for the Project

11. The facilities provided by CIDA in the complex would, as indicated, have to be extended to the Project site. The cost, implementation schedule and responsibility for extension of the primary services is shown in Table 1. In addition, the Company has to provide other services itself. The Project incorporates generation, storage and inter-plant distribution systems as appropriate for all services. These are discussed below.

1. Water Supply

12. HII plans to receive water for use in the Project through a tee-connection by a 300 mm diameter pipe running for 2 km (refer to Map). The responsibility for the connection and its estimated cost of US$145,000 is under discussion between the Government and HII. The connection is scheduled to be in place by June 1977. The 300 mm diameter pipe has adequate capacity to service the Project's requirements of 5,000 m^3/day. This includes 1,200 m^3 for plant use, 1,850 m^3 for living and working human needs and 1,950 m^3 for steam generation purposes (for details see Table 2).

13. The terminal pressure at the site is expected to be 4 atmospheres which would permit direct feed into two elevated, underground concrete storage tanks of 5,000 m^3 capacity each. The two tanks would be interconnected for flexibility and would provide for requirements of 2 days.

2. Electricity Supply

14. Power requirements will be provided by the Korea Electric Company off an existing 154 kV transmission line (refer to Map). The power supply would be at 154 kV, 3 phase and 60 Hz and would feed into the 154 kV incoming circuit breakers (see Chart 1). The dual circuit breakers would be provided by the Korea Electric Company and the responsibility of the remainder of the network would rest with HII. The dual incoming circuit breaker would serve as a standby arrangement together with the necessary maintenance facilities. The circuit breaker will feed into four transformers of 40 MVA each, the ratio of transformation being 154/22.9 kV. The distribution network further comprises seven substations attached to the facilities thus making available three voltage levels of 22.9 kV, 6.6 kV and one low voltage level at 380 V (not shown).

15. The total requirements of the facilities are indicated below and amount to 135,000 kW, around 50% of which is directly attributable to the foundry. The electrical distribution system provides for requirements of upto 150,000 kVa.

HII: Power Requirements and Capacity

Facility	Electric Power Demand (kW)	Transformer Capacity (kVA)
1. Assembly Shop 1/	17,800	20,000
2. Heavy Machine Shop	9,500	10,000
3. Light Machine Shop	7,600	10,000
4. Foundry	67,900	70,000
5. Forging Shop	2,300	5,000
6. Fabrication Shop	20,000	20,000
7. Utilities and Support Facilities	10,700	15,000
Total	135,800	150,000

1/ Includes requirements for administrative and residential areas.

3. Roads

16. Two access roads are planned to the Project site which will together form a loop with the Changwon complex road network (refer to Map). The first road will run along the sea and link the site to the proposed harbor and

indirectly to the central area of the complex. A 30 m. wide paved road is planned for completion by early 1978 with the possibility of a single lane by April 1977. The responsibility for its construction at a cost of US$1.5 million rests with the provincial government. The second road (3 km) would link the site to the central complex area and include a 500 m. tunnel through the dividing hill. The road is estimated to cost around US$2.6 million but has not yet been planned in detail. The design for the seaside road does take into account the load requirements for the Project and its design capacity is around 10 tons/axel with headroom of 4.5 m. It was originally intended to service the site with a rail-link. It was subsequently found to be uneconomical and excluded.

4. Sewage and Trade Effluent Treatment

17. The Project provides facilities for the treatment of industrial and other wastes and would be in compliance with existing legislation. It incorporates an adequate sewage disposal and drainage system that embodies a number of submersible pumping stations. The effluents from each facility would be treated by a number of methods such as filtering, absorption, thickening and neutralizing methods. The composition of the discharge and the required treatment facilities have generally been determined and are detailed in Annex 4-6, Ecology. The plans for the location of the treatment facilities are being finalized.

5. Communications

18. HII will draw a maximum of 30 outside lines from the complex exchange along the electric poles currently in place for the village along the Project site. The Company will operate a manual switchboard system with an estimated 500 internal lines supplemented by public and portable address systems.

6. Other Utilities

19. The total requirement for all other utilities/services has been estimated and is shown in Table 2. The gas requirements will mostly be met by purchase from Union Gas Company, under construction in the complex and scheduled for completion by 1977. The distribution system from the Gas Company to the end-users has not been finalized. Distribution is expected to be done utilizing tanks and the Project incorporates adequate storage facilities on site. Compressed air requirements will be generated at four large stations attached to the Forge/Foundry shop, Light Machine Shop, Heavy Machine Shop and Fabrication Shops. Smaller compressors will be provided within the facilities to meet special needs. The total requirement for compressed air is estimated at 15,000 Nm^3/hr ($7Kg/cm^2$) or a maximum of around 50,000 M^3/day. Receiver tanks at the compressor stations are provided for adequate storage. Distribution of compressed air will be by overhead lines along with Oxygen and Acetylene lines in the plant. Distribution outside the plant will be underground.

20. The steam requirements of 1,950 tons maximum per day will also be generated on site. The boiler facilities provided for in the Project include self-contained units with vertical type boilers for the administration and residential units and a centralized boiler station for process steam and plant heating. The centralized station will include 3 boilers with a capacity of 50 tons/hour at 30 kg/cm^2, and 2 sets with a capacity of 30 tons/hour at 7 kg/cm^2.

21. Fuel and oil requirements will be procured from existing fuel companies in Korea which will be responsible for delivery on site by trailer and/or ship. The largest requirement will be for Bunker 'C' oil estimated at 300,000 tons/year. The Project includes over-ground centralized storage facilities in the form of two tanks of 10,000 m^3 capacity. Smaller tanks will be available for storage of gasoline and lubricants and machining oils will be stored in drums. The boiler stations also include underground servicing tanks for their requirements of Bunker 'C' oil.

7. Social Facilities

22. The Company plans to build residential facilities for upto 1,200 of its bachelor work-force, the remainder being expected to reside in the housing facilities included in the Changwon complex. The Project includes a dispensary, recreation hall and adequate dining facilities for the work-force in both the living and the plant areas. It also provides accommodation for upto 160 visiting expatriate and local technicians. The Project also includes a Guest House.

D. Conclusion

23. The infrastructure provided for in the Changwon complex and supplemented within the Project is considered to be satisfactory. The Project has access to an adequate transportation system, water and electricity supply system through the complex. The interplant services built into the Project Design at this stage are suitable and will be reviewed again and finalized as the facilities are planned in further detail.

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KOREA

HEAVY MACHINERY PROJECT

PROJECT PLAN OF INFRASTRUCTURE

Description		Content	Quantity	Investment $	Completion	Responsibility
1. Water Pipe		Jyuk-hyun--Plant	300 Dia x 2 Km	145,000	June, 1977	Under Discussion
2. Electricity		Jyuk-hyun--Plant	154 KV x 3 Km	420,000	End of 1977	Korea Electric Co.
3. Road:	Seaside	Jyuk-hyun--Plant (Harbor)	30 M x 2 Km	1,502,000	June, 1977	Provincial Government
	Direct	Central Area--Plant	30 M x 3 Km	2,585,000	June, 1978	Changwon Authority

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ANNEX 4-8
Table 1

KOREA

HEAVY MACHINERY PROJECT

WATER REQUIREMENTS

Use	Specification	Unit Requirement	Calculation	Total Requirement (m3)
Machine Water				
a. Arc Furnace	120 ton	5 m^3/ton/hr	5 x 120 x 24 hrs x 5% [1/]	720
b. Holding Furnace	120 ton	2.5 m^3/ton/hr	2.5 x 120 x 24 hrs x 5 %	360
c. Compressor	1,100 HP total	0.4 m^3/HP	0.4 x 1,100 x 5%	25
d. Heat Treatment	40 M/T/day	1 m^3/M/T	1 x 40	40
e. Paint, Others	1/2" x 7 sets	1.5 m/sec		55
Working				
Direct Labor	3,500 persons	0.3 m^3/person	0.3 x 3,500	1,050
Living				
a. Direct and Indirect Labor	6,345 persons	0.08 m^3/person	0.08 x 6,345	510
b. Dormitory	1,400 persons	0.2 m^3/person	0.2 x 1,400	290
Sub-total				800
Heating				
Boilers			1,950 m^3/hr	1,950 [2/]
TOTAL				5,000

1/ 5% Replacement Ratio

2/ Steam requirement in m^3 water equivalent:

Process Steam	1,200 m^3
Heating	695 m^3
Working and others	55 m^3

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Table 2

KOREA

HEAVY MACHINERY PROJECT

UTILITY/SERVICES REQUIREMENT

Utility/Service	Requirement		Storage Method	Storage/Generation Capacity	Source
	Day	Year			
Oxygen	2,250 M3	675,000 M3	Liquid Oxygen and evaporator	10 x 2 sets	Union Gas Co. (Changwon Complex)
Acetylene	195 M3	58,500 M3	Cylinders	225 ft.3 outside cylinders	Other sources in Korea
Argon	110 M3	33,000 M3	Cylinders (10 Kg/cm2)	6 M3 cylinders	Union Gas Co.
CO_2	220 M3	66,000 M3	Cylinders (10 Kg/cm2)	6 M3 cylinders	Other sources in Korea
Hydrogen	4 M3	1,200 M3	Hydrogen bottles	6 M3 x 30	Other sources in Korea
Air	50,000 M3 max.	-	Receiver tanks at local compressor station	50 M3 x 1 sets 300 M3 x 3 sets 200 M3 x 2 sets 100 M3 x 2 sets	On-site
Steam	1,950 tons max.	-	-	50 tons/hr - 3 sets 30 tons/hr - 2 sets 8 tons/hr - 1 set 3 tons/hr - 1 set	On-site
Bunker "C" Oil	1,336 tons max.	300,700 tons	Storage tank	10,000 M3 x 2 sets	Oil companies in Korea

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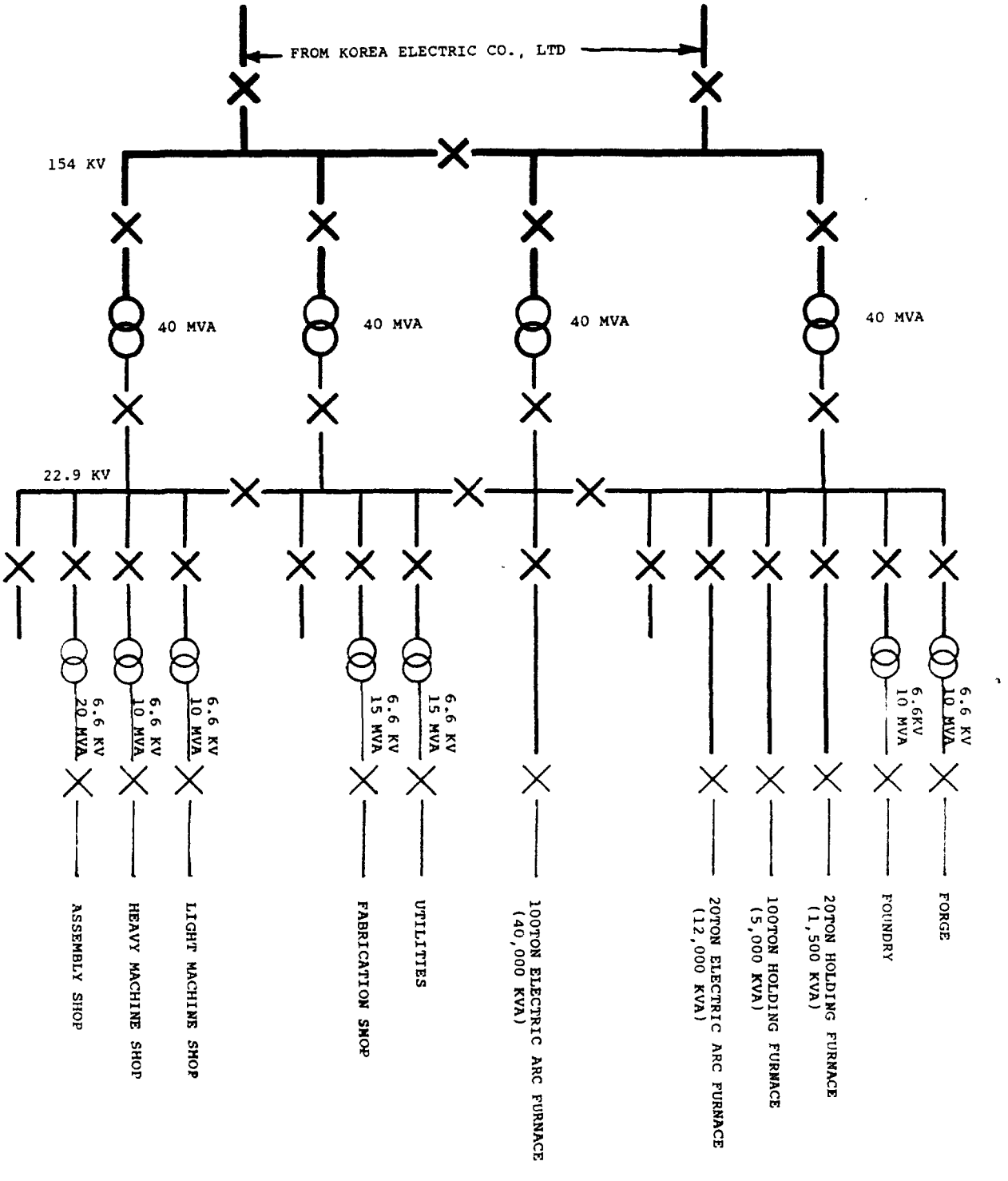
ANNEX 4-8
Table 3

KOREA

HEAVY MACHINERY PROJECT

ELECTRIC POWER SINGLE LINE DIAGRAM



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KOREA

HEAVY MACHINERY PROJECT

CAPITAL COST ESTIMATES

A. Summary

1. The capital cost estimates based on the technical studies carried out by HII and IMC are summarized below. The cost estimate for each major facility is shown in Table 1. An estimate of indirect foreign exchange cost included in the local cost estimates is also shown below:

Cost Estimate Summary (US$ million)

		Local			Foreign	Total	%
		Purely Local	Indirect Foreign	Sub-Total			
1.	Civil Works	15.8	2.0	17.8	-	17.8	9.1
2.	Buildings	14.0	1.5	15.5	7.0	22.5	11.6
3.	Equipment (CIF Plant)	29.4	7.2	36.6	/1 94.2	130.8	67.2
4.	Installation	9.8	2.1	11.9	-	11.9	6.1
5.	Pre-operating expenses	5.2	-	5.2	6.4	11.6	6.0
	Base Cost	74.2	12.8	87.0	107.6	194.6	100.0
6.	Physical Contingency	7.4	1.3	8.7	10.8	19.5	10.0
7.	Price Contingency	17.4	2.9	20.3	20.7	41.0	21.1
	Total Fixed Assets	99.0	17.0	116.0	139.1	255.1	131.1

/1 Includes 2% duty (after 90% exemption) and 2.5% defense tax.

2. The base cost estimates are based on mid-1976 prices. The Project cost estimates, which are prepared jointly by HII and IMC, are based on quotations received by the Company, enquiries made by IMC and the Company's recent experience in the implenentation of Gunpo Plant. Some preliminary quotations received in March 1976 from potential suppliers were modified to July 1976 price to reflect the price increase between March and July 1976. No further modifications are expected as a result of the final review by the

consultants. The details of the cost estimates, which were reviewed by the Bank on an item by item basis and are considered realistic, are elaborated below.

B. Civil Work (Item 1)

3. The civil works cost estimates are based on detailed assessment of various items such as land purchase, earth work, site preparation, and water supply and disposal. These cost estimates are summarized below.

Category	Quantity	Cost/Unit (US$/Unit)	Cost Estimate (US$ 000) Local	Foreign	Total
(i) Land Purchase	3.24 million m^2	0.87/m^2	2,810	-	2,810
(ii) Earth Work	5.9 million m^3	1.10/m^3	6,490	-	6,490
(iii) Rock Blasting	700,000 m^3	6.50/m^3	4,550	-	4,550
(iv) Anti-Penetration (MAT)	500,000 m^3	0.70/m^3	370	-	370
(v) Culverts	14,000 m	147.0/m	2,060	-	2,060
(vi) Roads	109,300 m^2	8.0/m^2	880	-	880
(vii) Water Supply and Disposal			630		630
Total			17,790	-	17,790

4. The land purchase includes the price of land and the compensation to be paid to about 250 families currently living there. The earth work of about 6.4 million m^3 includes the reclamation of about 0.5 million m^2 of land presently under water. The filling itself will be about 5 million m^3. Of the total 6.4 million m^3 earth work, about 0.5 million m^3 will require rock blasting; this will cost about 6 times more than normal earth work. MAT process will be utilized to cover the bottom of the area covered by water at present. This is done primarily to reduce cost of piling. Piling cost is included with the building cost. Various types of culverts are required at the plant site. The cost per meter of hume pipe culverts will vary between US$70.0/m and US$23.0/m for 1,000 mm and 450 mm pipes respectively.

Box culverts are estimated to cost around US$500/m. About 10.9 km of paved road with an average width of 10 m is required for the project. The cost of pavement of about US$8/$m^2$ is used to derive the total cost of road work. The water supply system, including two 5,000 m storage tanks and necessary pipe works, is estimated to cost around US$330,000. The waste water disposal, including a treatment plant for 600 m^2/day, is estimated to cost about US$300,000. The civil works will be carried out by HII and Hyundai Construction Company and these costs are calcualted on the basis of their recent experience in the country. This being the case, the cost estimates given above are considered realistic.

C. Building (Item 2)

5. The building cost estimates are based on the floor space and piling requirements of each facility. HII's recent experience in the construction of its Gunpo Plant is used to derive unit cost of construction of these buildings. Detailed estimates of building cost by facility are given below.

	Category			Cost Estimate (US$000)		
	Buildings	Floor Space m^2	Unit Cost US$/$m^2$	Local	Foreign	Total
(i)	Foundry & Forge shop	65,500	86	3,220	2,420	5,640
(ii)	Fabrication shops	55,000	86	3,400	1,430	4,870
(iii)	Heavy Machine shop	35,700	123	2,370	2,010	4,380
(iv)	Light Machine shop	15,000	55	760	70	830
(v)	Assembly shop	17,500	123	1,150	990	2,140
(vi)	Support Facilities	27,900	46	1,180	110	1,290
(vii)	Other Buildings	41,900	80	3,330	-	3,330
	Total			15,450	7,030	22,480

6. The above estimates include the foundation work required for each shop. Since some of the structures required for the heavy building are not available in the country, they will have to be imported. The unit price of buildings varies between US$46 and US$123/m^2 because of the difference in building structure and foundation work. The cost of utility work inside the buildings is included under the installation cost category. Based on the actual costs experienced at Gunpo facilities, these cost estimates are considered satisfactory.

D. Equipment (Item 3)

7. For most of the equipment and machinery required for the project, HII has received quotations from various suppliers in Japan, Western Europe and the U.S.A. On an average about 3 to 5 bids were received for most of the items. Some of these price quotations, particularly for critical items, were further verified by IMC. In order to reflect the price increase between March 1976 and mid 1976, the quoted prices of March 1976 of some items were adjusted to mid 1976 to arrive at the base price estimates. The equipment cost estimates also include the cost of necessary spare parts and transport cost to the plant site. The following are the cost estimates for foreign as well as local equipment (c.i.f., Plant), including spare parts:

Category		Cost Estimates US$000		
		Local	Foreign	Total
(i)	Foundry & Forge	14,200	20,900	35,100
(ii)	Fabrication shop	5,000	9,200	14,200
(iii)	Heavy Machine shop	3,100	35,400	38,500
(iv)	Light Machine shop	1,200	9,300	10,500
(v)	Assembly and Test Shop	5,300	9,400	14,700
(vi)	Support facilities	3,000	7,800	10,800
(vii)	Others	4,800	2,200	7,000
	Total	36,600	94,200	130,800

8. Of the total equipment cost, about 38% would be for the machine shops and about 27% for foundry and forge shop. The cost of tooling and spare parts, which are included in the above estimate, are based on a percentage of total equipment cost, which ranges between 2% in certain areas like assembly shop to 7% for heavy machine shop. An allowance of about 3% of equipment cost of imported items has been assumed to compute freight and insurance charges. Of the total of US$130.8 million worth of equipment, about US$47.1 million will account for equipment made in-house using the

knocked down kit approach. An average duty of 20% is normally applicable to the machinery and equipment to be imported for the Project. By virtue of the nature of the Project and its location in the Changwon complex it would enjoy 90% exemption from such duties. Accordingly a duty of 2% and the applicable defense tax of 2.5% have been included in the above estimates.

E. Installations (Item 4)

This item includes cost estimates for utility installations (with the exception of water distribution), erection, commissioning, and specific foundations. Detailed breakdown of cost items are given below:

Category	Cost Estimates US$000		
	Local	Foreign	Total
(i) Utilities	7,300	-	7,300
(ii) Erection & Commissioning	2,900	-	2,900
(iii) Special Foundations	1,700	-	1,700
Total	11,900	-	11,900

10. The cost estimates for utilities are based on different unit prices/unit floor space, which varies between US$35/$m^2$ for residential and administrative buildings to US$14.5/$m^2$ for production facilities. Based on Gunpo experience, the erection and commissioning charges have been assumed at 2.2% of equipment cost. These estimates are considered reasonable.

F. Pre-operating Expenses

11. The estimate of this item is based on the Company's past experience and also takes into account the requirements of this project with respect to technical assistance, license fees and training requirements. The technical assistance and engineering category includes around US$1.0 million for 50 man-months of consultancy in the general/machining/assembly and 70 man-months in the foundry/forge areas. The costs are derived on a man-month base cost of US$6,040 and US$5,950 and after including travel expenses, overheads and discounts approximate an average cost of US$8,300 per man-month for the two areas. The following is the estimate of the cost elements included under this item:

	Category	Cost Estimates US$000		
		Local	Foreign	Total
(i)	Training	700	1,400	2,100
(ii)	Technical Assistance & Engineering	1,500	2,500	4,000
(iii)	Travel	500	500	1,000
(iv)	Expediting	200	-	200
(v)	Initial License Fee	-	2,000	2,000
(vi)	Others Pre-operating Expenses 1/	2,300	-	2,300
	Total	5,200	6,400	11,600

1/ Local staff time, rent, office equipment, etc.

G. Physical Contingency

12. To cover minor scope changes and possible omissions of equipment and civil works, a 10% physical contingency has been added to the total base cost estimate, including pre-operating expenses. This contingency provision is considered necessary since the final details of the Project has yet to be developed.

H. Price Contingency

13. The base cost estimates are based on mid-1976 prices. Price escalation has been added to both local as well as foreign cost estimates, to provide for future project cost increases. The price escalation is applied to base cost and physical contingencies. The following annual price increases for local and foreign costs were used in calculating price contingency.

	Annual Rate of Increase	
Year	Local	Foreign
1976	13%	9%
1977 - 79	12%	8%
1980 onward	10%	7%

14. Total price escalation is estimated at US$41.0 million (US$20.7 million on foreign exchange cost and US$20.3 million on domestic costs). This price contingency, which represents about 21% of the base cost estimate, is considered adequate.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

CAPITAL COST ESTIMATES BY FACILITY

(US$ Million)

Category	Foundry/Forge Shop			Fabrication Shops			Heavy Machine Shop			Light Machine Shop			Assembly/Test Shop			Support Facilities			Other Facilities			Total		
	LC	FE	Total	LC	FE	Total	LC	FE	Total	LC	FE	Total	LC	FE	Total	LC	FE	Total	LC	FE	Total	LC	FE	Total
I. Civil Works 1/	2.1	-	2.1	5.2	-	5.2	1.5	-	1.5	1.0	-	1.0	2.2	-	2.2	2.9	-	2.9	2.9	-	2.9	17.8	-	17.8
II. Buildings	3.2	2.4	5.6	3.4	1.4	4.8	2.4	2.0	4.4	0.8	0.1	0.9	1.2	1.0	2.2	1.2	0.1	1.3	3.3	-	3.3	15.5	7.0	22.5
III. Equipment																								
(1) Purchased	0.6	5.6	6.2	0.1	7.4	7.5	-	34.3	34.3	0.5	9.1	9.6	-	2.3	2.3	2.3	7.7	10.0	4.7	2.1	6.8	8.2	68.5	76.7
(2) Made-in-house	12.5	14.9	27.4	4.4	1.6	6.0	1.1	0.5	1.6	0.2	-	0.2	4.8	6.9	11.7	0.2	-	0.2	-	-	-	23.2	23.9	47.1
(3) Freight & Insurance	0.2	0.4	0.6	0.1	0.2	0.3	0.4	0.6	1.0	0.1	0.2	0.3	0.1	0.2	0.3	0.1	0.1	0.2	-	0.1	0.1	1.0	1.8	2.8
(4) Duties & Taxes	0.9	-	0.9	0.4	-	0.4	1.6	-	1.6	0.4	-	0.4	0.4	-	0.4	0.4	-	0.4	0.1	-	0.1	4.2	-	4.2
Sub-total	14.2	20.9	35.1	5.0	9.2	14.2	3.1	35.4	38.5	1.2	9.3	10.5	5.3	9.4	14.7	3.0	7.8	10.8	4.8	2.2	7.0	36.6	94.2	130.8
IV. Erection & Installation	3.8	-	3.8	2.5	-	2.5	2.1	-	2.1	0.9	-	0.9	1.1	-	1.1	0.9	-	0.9	0.6	-	0.6	11.9	-	11.9
V. Pre-operating Expenses	1.5	1.3	2.8	0.8	1.1	1.9	0.4	2.3	2.7	0.5	0.6	1.1	0.9	0.5	1.4	0.4	0.4	0.8	0.7	0.2	0.9	5.2	6.4	11.6
Total Base Cost	24.8	24.6	49.4	16.9	11.7	28.6	9.5	39.7	49.2	4.4	10.0	14.4	10.7	10.9	21.6	8.4	8.3	16.7	12.3	2.4	14.7	87.0	107.6	194.6
VI. Physical Contingency																						8.7	10.8	19.5
VII. Price Escalation																						20.3	20.7	41.0
Total Fixed Assets																						116.0	139.1	255.1

1/ Distributed among facilities on the basis of plant area requirements
2/ Distributed on a prorata basis

Industrial Projects Department
April 1977

ANNEX 5-1
Table 1

KOREA

HEAVY MACHINERY PROJECT

HII: WORKING CAPITAL REQUIREMENTS FOR THE PROJECT

1. Details on working capital requirements for the project are given in Table 1 at the end of this Annex. Principal assumptions used are summarized below. In general, however, it should be noted that turnovers of accounts receivable, inventories, and accounts payable will be lower than normal in the early years of project operations when sales and related costs are increasing throughout the year. Normal turnovers will be achieved from 1982 onward when revenues and expenses have reached steady state, or close to steady state levels.

2. Minimum Cash: forecast at 2% of sales.

3. Accounts Receivable: are based on the assumed billing pattern for project sales. That is, 80% of the sales value of work done will be billed before shipment (in the form of progress billings) and 20% will be billed at the time of shipment. One half of this will be received at the time receipt of the equipment by the customer and one-half after completion of acceptance tests. Turnovers on the two types of billings are assumed as follows:

Progress billings: 7.5 times 1978-80
8.0 times 1981
9.0 times 1982 and beyond
Average turnover on HII's accounts receivable in 1976 was 8.7 times.

Billings on shipment: 2.0 times on the first 10%
1.0 times on the second 10%

4. Advances to Suppliers: HII will be required to make progress payments to suppliers on bought-out items with long manufacturing lead times. It is assumed that one-half of bought-out items will be of this nature. It is also assumed that progress payments total 80% of the purchase cost of such items, 40% being paid in the year prior to receipt of the goods and 40% in the year of receipt. Thus, advances to suppliers at the end of any single year will equal 20% of the total of the cost of the following years' bought-out parts.

5. Materials and Supplies: are based on the following assumed turnovers: 5.0 times 1978-80, 5.5 times, 1981, and 6.0 times thereafter. Average turnover achieved by HII in 1976 was 5.6 times.

6. Goods in Process: The average manufacturing period for items to be produced by the project is assumed to be six months. This reflects the fact that while the manufacturing period for completed components in much longer, often one to two years, partial shipments will be made to the customer during this time. Turnovers are forecast as follows: 2.5 times, 1978-81, and 3.0 times thereafter. Finally, goods in process inventories are valued at sales value since HII is assumed to realize income on work done on a percentage of completion basis.

7. Accounts Payable: are based on total cost of sales plus selling and administrative costs, less labor costs included in these amounts. Costs of bought-out parts with long manufacturing lead times are also excluded since the payment method on these items will differ from other purchases. Turnover on the balances so arrived at are projected as follows: 4.0 times, 1978-79, 4.5 times, 1980-81, 5.0 times thereafter. Average turnover on HII's accounts payable in 1976 was 4.0 times. For bought-out parts with long manufacturing lead times, it is assumed that the 20% not made in progress payments (see para. 4) will be paid in the year following receipt of the goods. Thus, accounts payable for such items (which represent 50% of bought-out parts costs) at the end of any single year will equal 10% of the total cost of that year's bought-out parts.

8. Advances from Customers: are assumed to amount to 80% of the value of work in progress at year end plus 10% of the following year's sales. The latter amount represents deposits received by HII on orders placed by customers.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

WORKING CAPITAL (PROJECT)

(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ASSETS											
CURRENT ASSETS											
MINIMUM CASH	-	-	.43	1.78	2.87	3.88	5.39	6.35	6.79	7.27	7.77
ACCOUNTS RECEIVABLE	-	-	5.14	21.41	33.75	45.59	63.33	74.57	79.78	85.38	91.34
ADVANCES TO SUPPLIERS	-	2.16	8.02	11.09	11.92	12.79	11.95	12.79	13.68	14.64	15.60
MATERIALS AND SUPPLIES	-	-	6.65	13.36	20.16	20.84	26.53	28.34	30.32	32.45	34.71
WORK IN PROGRESS	-	-	17.12	35.68	57.44	77.60	89.74	105.66	113.05	120.98	129.44
TOTAL INVENTORIES	-	-	23.77	49.04	77.60	98.44	116.27	134.00	143.37	153.42	164.15
PREPAID EXPENSES AND OTHER	-	-	-	-	-	-	-	-	-	-	-
TOTAL CURRENT ASSETS	-	2.16	37.35	83.32	126.14	160.69	196.94	227.70	243.63	260.70	278.87
LIABILITIES AND EQUITY											
CURRENT LIABILITIES											
ACCOUNTS PAYABLE	-	-	7.95	18.78	26.60	33.69	39.58	43.29	46.31	49.56	53.03
ADVANCES FROM CUSTOMERS	-	2.14	22.62	42.90	65.35	89.03	103.52	118.48	126.77	135.65	145.70
TOTAL CURRENT LIAIBLITIES	-	2.14	30.57	61.69	91.95	122.72	143.11	161.76	173.09	185.21	198.73
WORKING CAPITAL	-	.02	6.78	21.64	34.19	37.97	53.84	65.93	70.54	75.49	80.14

ANNEX 5-2
Table 1

INDUSTRIAL PROJECTS DEPARTMENT
May 1977

KOREA

HEAVY MACHINERY PROJECT

PROJECT ORGANIZATION AND MANAGEMENT

A. Introduction

1. Three distinct phases of operation can be visualized in relation to the Project, requiring different forms of organization:

(i) Project Planning and Implementation Phase requring a Project form of organization directed towards the installation of the fixed facilities. Negotiation of licenses would also proceed in this period.

(ii) Operations start-up Phase requiring emphasis on coordination with licensors and involvement of expatriates to ensure technology transfer; and

(iii) Steady Operations Phase requiring an organization directed towards the successful achievement of the Project's objectives.

In the earliest stages, the effort would be directed from Company headquarters in Seoul with close communication and accountability to the President.

B. Project Team Organization

2. The proposed organization for the implementation stage is shown in Chart 1. As indicated, a large proportion of the staff including all key management personnel heave already been appointed. The organization is structured along four construction-related functions and a project planning and coordinating office. HII and the affiliated companies have a vast amount of project experience in implementing large projects such as the Hyundai Motor Plant, the Hyundai Shipyard and the Gunpo Plant and the proposed organization is based on this experience. The responsibilities of the key elements of the organization are discussed below.

Consultation Committee

3. The committee is comprised of all senior and other directors in the existing organization and advises the President and the Project leader on policy and other critical matters, bringing to bear the existing senior management experience in HII.

Project Leader

4. The Project leader is responsible to the President for all aspects of Project planning and implementation and directs all operations. In consultation with the President, he deals directly with existing and potential

licensors. The appointee has a proven track record of project implementation, with over 10 years experience in construction supervision and project management. Most notably, he managed the Hyundai Shipyard Project and was largely responsible for its successful completion.

Directors: Design and Engineering; Construction; Supply; and Finance

5. The Director for design and engineering is responsible for construction-related design aspects including site preparation and development, land reclamation process, infrastructure planning, building works and utility installation. The incumbent has been a practising Civil Engineer for over 15 years. He worked as the Engineering Manager for Industrial Plant Construction at Hyundai Construction Company before joining the Project team. The Director of the Construction oversees all construction activity on the site and is responsible for all related activities such as mobilization of manpower and equipment. The appointee to the job has been responsible for the construction of numerous significant projects for the Construction Company for the past 12 years.

6. The Supply Office is responsible for the procurement and delivery of all construction and ancillary supplies. This office would also carry out the function of procuring equipment for the Project, in consultation with the Project Planning and Coordination office. The Director for Finance and Accounting is responsible for all financial and cost-control aspects for the Project. The Directors all report to the Project leader directly.

Project Planning and Coordinating Office

7. This office carries out the important function of planning for the Project beyond the Construction phase. It is responsible for facility design, equipment selection, development of required resources and initial development of the market. In addition it serves as the interface between the remainder of the Project team and the Government, other outside agencies and the existing HII organization. The selected commercial manager has 12 years prior experience in Hyundai Group Companies in administrative and supply functions. Since 1968, he has been responsible for HII's license negotiations for existing operations and also served as the Coordinator of the Gunpo Expansion financed by the Asian Development Bank.

Licensing

8. The negotiation of licenses has already been undertaken and would continue to proceed through the first phase. This function is planned to be handled at the highest level with close collaboration between the President, the Project leader, the Director Project Planning and Coordinating and other staff with experience relevant to the license under discussion from both the technical and commercial points of view.

C. Operations Start-up Phase

9. The organization for this second phase will begin to take the form of the final organization, discussed below. The main difference would be one in emphasis awarded to various functions. The single most important function in this phase would be the successful transfer and implementation of technology. The technical organization and the role of expatriates and the Director of Technology Transfer would be critical at this stage. The technical organization chart is presented and discussed in Annex 4-3, as are the functions of the Director of Technology Transfer, and the involvement of expatriates.

D. General Operational Organization

10. The existing organization of HII (Annex 2-2) is structured functionally with the overall responsibilities for the Gunpo and Anyang plants being combined under one senior Director. The Company plans to set up a divisional structure with parallel organization for the Project, under the President, reflecting the size and importance of the Project in relation to existing operations. The organization would move away from the Project form and be directed towards the large scale of operations planned under the Project. The divisional organization for the Project would be functionally oriented with the greatest emphasis being placed on the critical functions of engineering and production. The proposed organization is shown in Annex 2-3 and discussed below.

The Policy Committee

11. The Company proposes to set up a Policy Committee comprising the President, Executive Vice-President and Vice-Presidents of the Project organization, of existing opertions and of corporate functions. The Policy Committee would essentially be a development of the consultation committee discussed earlier and would broadly be responsible for two areas:

(i) Basic policy development including development of effective senior management; and

(ii) Major pricing and delivery decisions involving market situation and strategy, price and cost strategy and technical delivery decisions.

In addition the Committee will serve as a strong link between existing and Project operations, and coordinate matters such as bidding for equipment to be jointly supplied by the Project and Gunpo.

Vice-President Changwon

12. The Vice-President would be responsible to the President for the overall execution of the Project. He would also be responsible to the Policy Committee for technology transfer and manpower development. He would be assisted by his team of Senior Directors.

Senior Director Operations

13. He would be responsible for overall operations management through Directors of Manufacturing, Engineering and Installation and Service. He would also be assisted by managers (not shown in Chart) in two key areas:

(i) Manager of Quality Assurance responsible for all aspects of quality including laboratory services; and

(ii) Manager of Contract Coordination responsible for ensuring coordination between engineering, manufacturing and installation and assisting the Senior Director Operations in preparation of technical and delivery recommendations to the Policy Committee.

Senior Director Finance

14. The Directors for Cost Control, and Accounting will report to this Senior Director who would be directly responsible to the Vice-President for the Project and the Policy Committee. To ensure integration he would also have an indirect relationship with the corporate Vice-President, Finance. Production cost control is expected to be critical to the success of the Project and accordingly HII proposes to appoint Managers for the functions of Project Cost Control, Product Costing, Variance and Performance analysis.

Directors of Administration and Marketing/Sales

15. The Director of Administration would be responsible for all administrative and personnel activities in collaboration with the corporate office. The proposed Marketing organization and functions, to be centralized at the corporate level, are discussed in Annex 3-3.

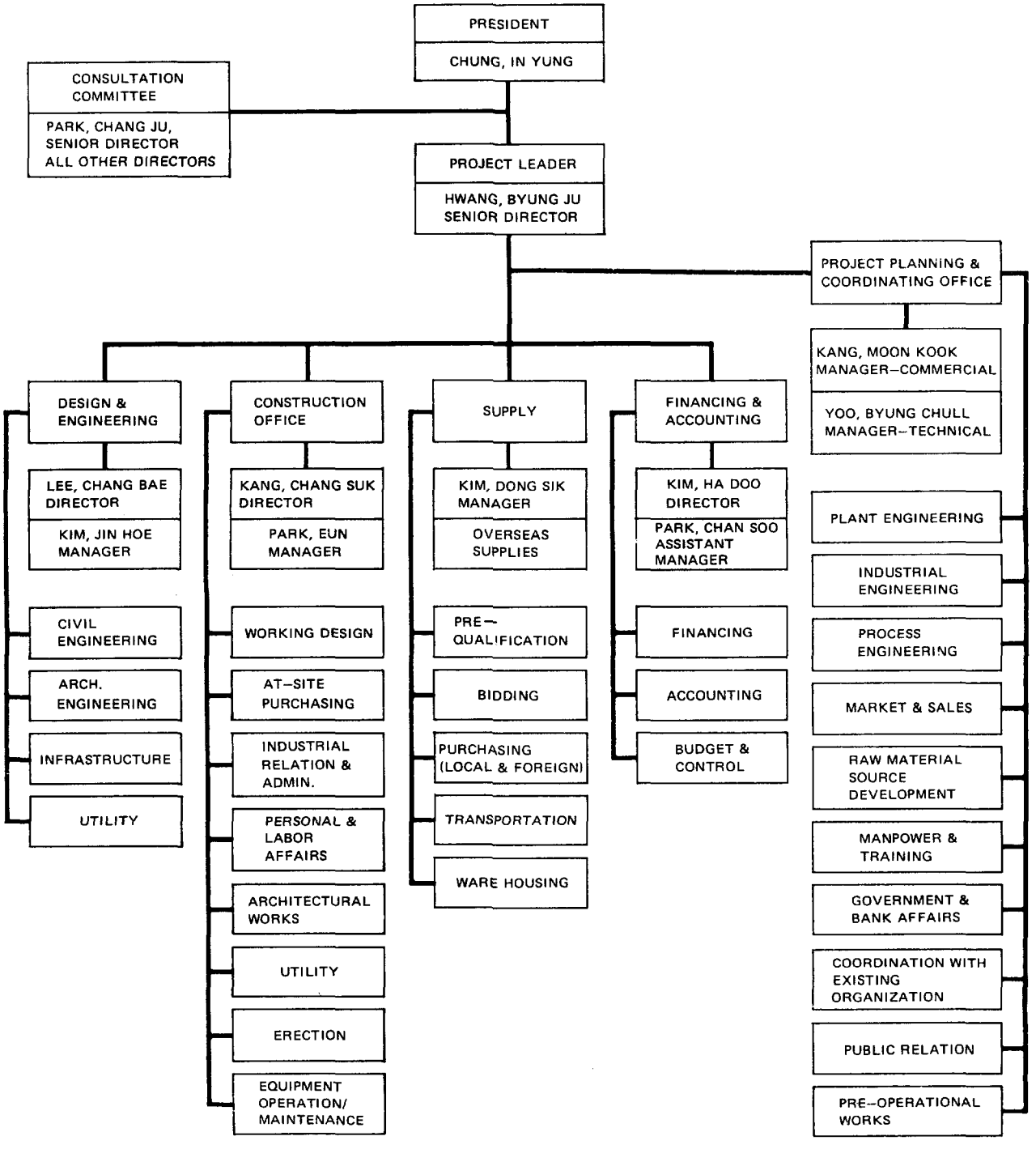
E. Conclusion

16. The proposed organization, separate from the existing operations and integrated at the top through the Policy Committee and additional integrated functions such as administration, finance and marketing, is considered satisfactory for the Project. The separation is important in view of the size and multi-product nature of the Project, quite beyond that of the existing operations. The coordination at the top should prove useful in drawing in existing in-house experience and ensuring co-operation between Gunpo and the Project in terms of resource utilization and component and parts supplies. The functional form is considered appropriate for the planned production volume and it is expected that as some product groups gain importance the organization would be restructured along product-group lines.

Industrial Projects Department
April 1977

ANNEX 6-1
Chart 1

KOREA
HEAVY MACHINERY PROJECT
Organization Chart of Project Team



Industrial Projects Department
January 1977

World Bank–16804

KOREA

HEAVY MACHINERY PROJECT

PROJECT IMPLEMENTATION

A. Introduction

1. The implementation schedule for the Project is shown in Chart 1. Site development and preparation for commencement of construction is already underway. Two sheds have been constructed to serve as a site-office and as dormitory space for the 22 personnel currently located there. The President has signed an order for release of the green-belt area for the plant, formal approval from the Government was granted at the end of 1976. A great deal of planning work had been completed in anticipation of this approval. Following finalization of details construction activity at a full scale will commence in the second quarter of 1977 and the Project is scheduled to be completed by the end of 1979. The Project is expected to reach the steady state of operation by 1983.

B. Implementation Steps

2. As indicated in Chart 1, implementation is planned to proceed in the following stages:

1. Project Development

3. The major parameters of the Project along with equipment requirements have been developed. These have been reviewed by HII with the assistance of consultants in the machining and assembly area (Ingersoll Manufacturing Consultants, already appointed) and are to be finalized following review by an operating company in the forge and foundry area (assistance agreement to be signed shortly). The review and detailed planning effort is expected to be completed in the second quarter of 1977.

2. Procurement

4. The initial phases of procurement upto the prequalification stage have been substantially completed. Following Bank approval advertisements for prequalification were placed in a number of international periodicals and the results are encouraging. The finalization of equipment specifications is planned to take place in stages in the first two quarters of 1977. As packages of equipment are finalized, tender documents are being prepared and following Bank approval bidding documents will begin to be sent out in March 1977. For further details see Annex 6-3, Procurement.

3. Site Development and Civil Works

5. The next step in this area is the mobilization of adequate resources, manpower and equipment, substantially completed as scheduled by the end of March 1977. The approach road being built by the provincial government (Annex 4-8, Infrastructure) will be ready for passage of one truck by May. The Korea Electric Company has also agreed to provide temporary construction power at that time. Earth-work including land-filling is scheduled to begin by April and with other construction work would be carried out by HII with the assistance of the Hyundai Construction Company. In view of the Company's recent successful experience at Gunpo, the approach is considered satisfactory. The equipment to be mobilized is shown in Table 1.

4. Building Works:

6. The building works for all facilities will generally proceed simultaneously, the residential facilities, training center and transformer station being scheduled for completion by the end of 1977. HII would import a part of their requirements of structural steels expected to be on hand by September 1977. HII will do a major portion of the structural work in-house. Piling and heavy foundation work is scheduled to begin in October 1977. A large portion of the building works would be completed by September 1978, the forge and foundry shop by the end of 1978 and the warehouse facilities by mid-1979. The installation of the main utilities would proceed simultaneously with the construction of the buildings.

5. Equipment Ordering and Installation

7. Machinery order placement is expected to commence in July 1977 after loan-aproval by the Bank, packages being sequentially ordered through the end of December. The schedule is consistent with the implementation program, and takes into account the different delivery periods for machinery. This proposed timing would apply to directly purchased equipment. License or manufacturing agreements for the purchase of knock-down kits for equipment to be fabricated and erected in-house would be discussed and negotiated simultaneously. As the critical items of purchased equipment are installed, they would be put into operation in manufacturing products and in fabricating parts for the knock-down kit equipment. For example, in the Foundry and Forge Shop, the 20-ton electric arc and holding furnace as well as the 100-ton hydraulic press are scheduled to be operational by the end of 1973 and would subsequently be utilized to manufacture heavy structural elements for the 100-ton units and for the 800-ton hydraulic press. Installation of such equipment would proceed through the end of 1979.

6. Operations Start-up

8. Start-up of the various facilities is planned to be phased to maximize the in-house content of the equipment through the knock-down kit

approach and for items such as welding tables. The proposed approach has the advantage of lowering investment cost and at the same time providing an opportunity for productive training. As indicated, the training center would be the first facility to be operational beginning January, 1978 but actual training of the work-force will begin even earlier especially in the area of fabrication. Of the plant facilities, the Light Machinery Shop would come on-stream next followed by the Fabrication Shop and the light equipment in the Foundry and Forge shop. These facilities scheduled to be fully completed by the end of 1978 would in fact begin manufacture of products with the assistance of the Gunpo plant by mid-1978. In this period they would also be involved in fabricating the knock-down kit equipment for the heavy portion of the foundry and forge and cranage equipment for the Heavy Machinery and Assembly Shops. These heavy facilities would be the last to become operational, the Heavy Machine Shop, the Assembly Shop and The Foundry and Forge in that sequence. In terms of fixed facilities the Project is scheduled to be fully operational by the end of 1979.

C. Conclusions

10. The implementation schedule outlined above is considered achievable in view of the Company's past performance, especially in light of its recent experience at Gunpo where the work is proceeding nearly six months ahead of schedule. However, the review to be undertaken with the assistance of an operating company in the forge/foundry area could lead to some minor revisions.

Industrial Projects Department
April 1977

KOREA

HEAVY MACHINERY PROJECT

EQUIPMENT TO BE MOBILIZED FOR CONSTRUCTION

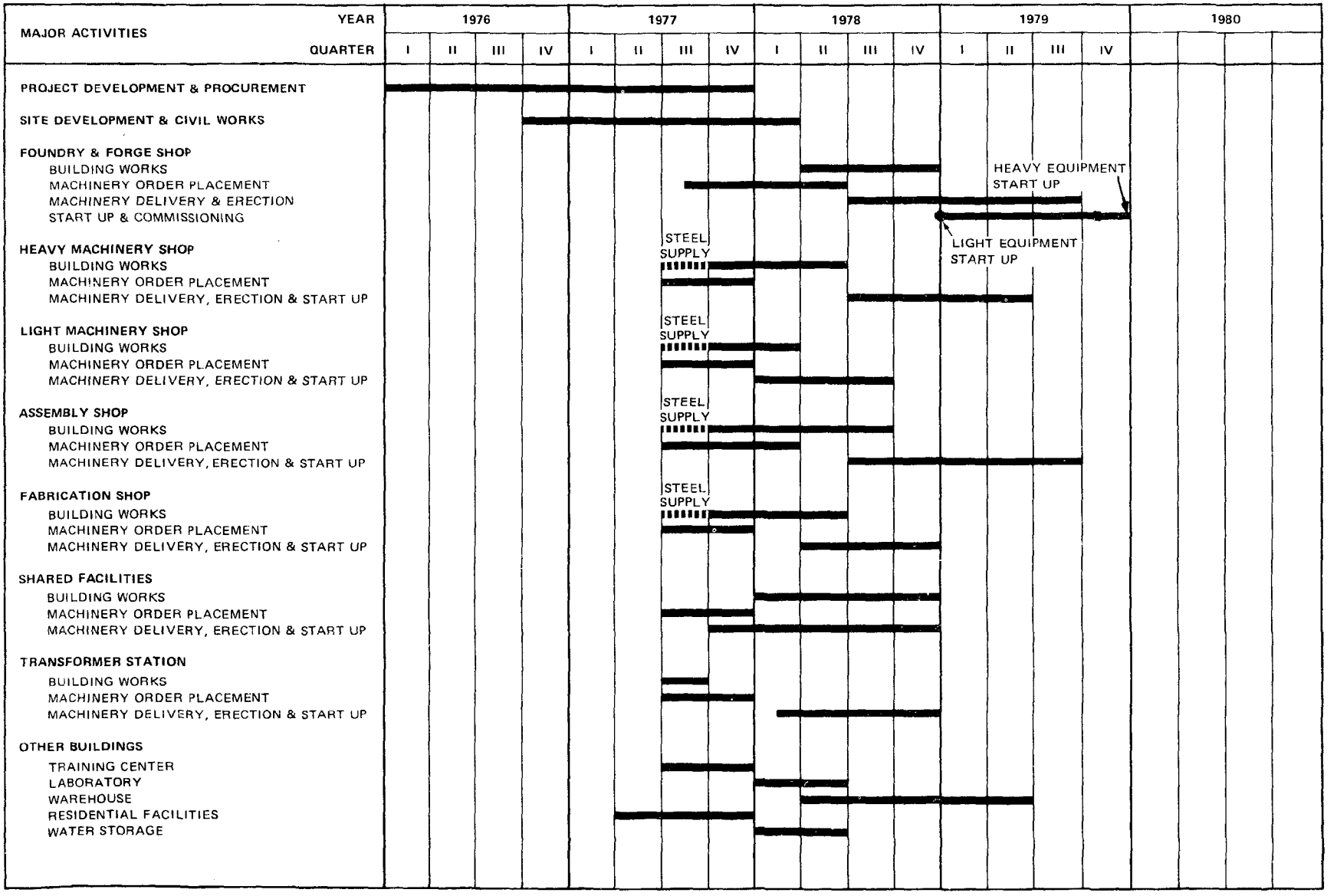
Equipment Item	Quantity (Units)
Bulldozers	20
Excavators	6
Pay-loaders	9
Dump Trucks	80
Crusher (200 ton capacity)	1
Concrete Mixers	7
Compressors	5
Tug-boat (200 H.P. rating)	1
Barge (500 ton capacity)	1
Mobile Cranes (15-125 ton range)	16
Hydraulic Cranes (25 ton capacity)	4
Fork lift Trucks (5-10 ton range)	4
Trailers (40 ton capacity)	2
Pile Hammer (5 ton capacity)	1
Welders (40 KVA rating)	200

Industrial Projects Department
February 1977

KOREA

HEAVY MACHINERY PROJECT

Project Implementation Schedule



Industrial Projects Department
January 1977

World Bank—16806

ANNEX 6-2
Chart 1

KOREA

HEAVY MACHINERY PROJECT

ITEMS TO BE FINANCED BY THE BANK

	Category	Amount of Loan Allocated[1/] (expressed in dollar equivalent) (US$ 000)
I.	Foundry and Forge shops:	5,000
	Steel-making, forging and heat treatment equipment	
II.	Fabrication shops:	6,000
	Hydraulic press (8,000 tons), bending and welding equipment	
III.	Machine shops:	48,500
	Plano-milling, boring, turning, grinding, shaping, slotting, drilling, and blade-making machines, induction heater, etc.	
IV.	Assembly and Test shop:	6,000
	Assembly lathe, balancing equipment	
V.	Laboratory facilities:	1,500
	X-ray equipment, ultrasonic tester, etc.	
	Total equipment and spares	67,000
VI.	Structural Steel	5,500
VII.	Technical Assistance	1,000
VIII.	Unallocated	6,500
	Total	80,000

1/ No further revisions are expected following final review.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

ESTIMATED DISBURSEMENT SCHEDULE[1/]

Year	Quarter	Disbursement	Cumulative	Undisbursed Amount
1977	III	9.1	9.1	70.9
	IV	3.7	12.8	67.2
1978	I	11.4	24.2	55.8
	II	16.2	40.4	39.6
	III	17.7	58.1	21.9
	IV	13.1	71.2	8.8
1979	I	4.8	76.0	4.0
	II	3.7	79.7	0.3
	III	0.3	80.0	0.0

[1/] Disbursements are based on the following assumptions on timing of payments:

	Down Payment	Progress Payments	On Shipment	After Performance Test
Structural Steel	-	-	100%	-
Equipment (Based On Delivery Period)				
Less than 6 months	10%	-	80%	10%
6 months to 12 months	10%	15%	65%	10%
More than 12 months	10%	30%	50%	10%

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

BASIS FOR FINANCIAL PROJECTIONS

1. Details on sales and operating costs for the project are given in Annexes 7-2 and 7-3. The information contained in these annexes has been used to prepare the projected income statements for the project alone given in Annex 7-4, page 2.

2. Projected income statements for HII as a whole (Annex 7-4, page 1) are based on those for existing operations (Annex 2-9, page 2) plus those for the project (Annex 7-4, page 2).

3. Projected balance sheets for HII as a whole (Annex 7-6) are based on those for existing operations (Annex 2-9, page 4) plus additional needs due to the project as determined in the source and application of funds forecasts contained in Annex 7-5.

Industrial Projects Department
April 1977

KOREA

HEAVY MACHINERY PROJECT

HII: PROJECTED SALES

A. Steady State Sales

1. The sales plan for the project is based on output capabilities at the 1983 steady state. At that time, the project will have reached fully efficient operations and, based on installed capacity, available man and machine hours, will be capable of producting:

(a) Equipment for one 3 million ton steel plant every three years;

(b) Equipment for 1,000 MW of power plant each year;

(c) A complete mix of chemical and petro-chemical plant equipment; and

(d) Small fabricated items, forgings and castings to achieve full capacity utilization.

Details of equipment to be produced by the project at the 1983 steady state are given in Table 1 of this annex.

B. Selling Price Assumptions

2. Selling prices assumed for project sales are mid-1976 prices for similar types of equipment purchased by Korean enterprises from suppliers in Japan, Western Europe and the U.S. In particular:

(a) Steel Plant: Actual purchase prices for POSCO's third expansion which is presently under construction, have been used as the basis of steel plant selling prices. Purchase prices for the first and second expansions (completed in 1973 and 1976 respectively), adjusted to mid-1976 price levels, were used in a few cases where information on the third expansion was not available.

(b) Power Plant: Actual prices at which KECO has purchased equipment for their current power plant projects were used as the basis of selling prices.

(c) Chemical Plant: Selling prices are based on prices from Japanese suppliers, which have been the main source of equipment for recent expansion projects in the Korean chemical and petrochemical industry.

3. Selling prices have been inflated from mid-1976 levels using the following inflation rates: 8%, 1977-79, and 7% thereafter. These rates are the same as the international inflation rates used for the calculation of equipment cost contingency allowances.

4. In the calculation of selling prices, no account has been taken of the fact that in the later years of the project HII will be bidding for steel, power and chemical plant on a turn-key basis. Accordingly, actual sales will include equipment not identified in Table 1, to be manufactured by other suppliers subcontracted by HII, as well as revenues for construction, erection and installation of the plants as a whole. The sales forecasts based on the equipment list in Table 1 are thus conservative.

C. Sales Build-up to the Steady State

5. Since it is still too early for Hyundai to have received orders for equipment to be produced by the project, sales through to the 1983 steady state are based on the assessment of the domestic market detailed in Annex 3-2. Consideration was also given to the build-up of in-house manufacturing capability from start-up in 1978 to steady state operations in 1983. For example, in 1978, it is estimated that HII wil produce about 49% of its output in-house, rising to 81% by 1983. Application of in-house manufacturing percentages to annual sales gives an indication of the "value-added" by HII each year. Thus, even though total sales are relatively high in the early years of project operations, many of the components will be bought-out from foreign suppliers rather than manufactured by HII. Details on sales projections for the project are shown in Table 2 of this annex.

D. Areas of Conservatism in Sales Forecasts

6. The sales forecasts given Table 2 are believed to be conservative, for the following reasons:

(a) Sales are forecast for the original equipment market only. No account has been taken of potential sales to the replacement market.

(b) No account is taken of possible export sales. In particular, HII alone or in association with its licensors, will be capable of supplying equipment to offshore markets.

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KOREA

HEAVY MACHINERY PROJECT

HII: PROJECTED SALES

Steady State Sales (1983)

	Capacity	Sales Value[1] (US$ Millions) (1976 terms)	Weight[2] (Tons)	Sales Value per Ton (US$)
A. STEEL PLANT				
Iron Making Facilities				
Sintering Plant	11,760 tons/day	31.3	13,500	2,316
Coke Plant	4,250 tons/day	34.3	17,300	1,979
Iron Making Plant	7,540 tons/day	53.7	18,100	2,961
		119.3	48,900	2,421
Steel Making Facilities				
Steel Making Plant	3 million tons/year	44.4	10,000	4,449
Lime and Calcinating Plant	600 tons/day	4.0	1,700	2,369
Continuous Casting Plant	0.7 million tons/year	10.4	2,500	4,124
		58.8	14,200	4,146
Rolling Mill Facilities				
Blowing and Slabbing Mill	2.8 million tons/year	42.8	17,400	2,455
Hot Strip Mill	2.0 million tons/year	54.8	19,500	2,807
Cord Strip Mill	0.5 million tons/year	37.0	11,800	3,143
Plate Mill	1.4 million tons/year	59.3	19,800	2,992
Section Mill	0.3 million tons/year	17.3	6,200	2,800
		211.2	74,700	2,806
25% of Rolling Mill Facilities[3]		52.8	18,700	2,806
Total Steel Plant to Be Sold Over 3 Years		230.9	81,800	2,823
Steel Plant Annual Sales		76.9	27,300	2,823
B. POWER GENERATION PLANT				
Boiler)		92.4	10,530	8,775
Turbine-Generator)	Equipment capacities as	38.4	2,800	13,714
Condensing Equipment)	defined by 2 sets of 500MW	10.9	1,060	10,283
Feed Water Equipment)	power plants each year.	17.9	630	28,413
Power Plant Annual Sales		159.6	15,020	10,626
C. CHEMICAL AND PETROCHEMICAL PLANT				
Reactor		10.2	2,040	5,000
Heat Exchanger		20.4	5,670	3,600
Vessels and Tanks		8.7	2,410	3,600
Columns and Towers		11.7	3,260	3,600
Process Machinery		19.2	6,000	3,200
Pumps and Compressors		9.8	2,510	3,900
Chemical Plant Annual Sales		80.0	21,890	3,655
Total Key Product Annual Sales		316.5	64,210	4,929
Ancillaries Sales[4]		47.5	18,480	2,570
Jobbing Sales[5]		32.0	17,310	1,850
TOTAL ANNUAL SALES		396.0	100,000	3,960

1/ Basis of selling prices given in page 1 of this Annex.

2/ Equipment weights obtained by HII from information supplied by POSCO and KECO on their equipment purchases and from licensors.

3/ Based on existing information on capacities at the steady state, the project would not have sufficient heavy machining capacity to produce a complete line of rolling mill equipment for the steel plant. Thus, assumed sales have been reduced to 25% of the original figure for rolling mills.

4/ Ancillary sales represent peripheral equipment which, while they are part of the packages to be sold for steel, power, and chemical plant, have not been specifically identified under key product sales. They are forecast at 15% of key product sales.

5/ Jobbing sales (fabricated items, forgings, castings etc not related to key product sales) are forecast at 10% of key product sales.

Industrial Projects Department
February 1977

KOREA

HEAVY MACHINERY PROJECT

HII: PROJECTED SALES

SALES BUILD-UP 1978-86

	1978[1]	1979	1980	1981	1982	1983[2]	1984	1985	1986
A. Sales in Constant 1976 US Dollars (Millions)									
Market for Steel Plant [3]	108.0	194.0	252.0	223.0	200.0	200.0	200.0	200.0	200.0
HII Market Share	5%	15%	16%	22%	33%	38%	38%	38%	38%
Sales-Steel Plant [4]	5.8	29.0	40.0	48.0	66.0	76.9	76.9	76.9	76.9
Market for Power Plant [3]	75.0	255.0	350.0	420.0	445.0	445.0	445.0	445.0	445.0
HII Market Share	37%	29%	34%	29%	39%	36%	36%	36%	36%
Sales-Power Plant [4]	28.0	73.0	118.0	123.0	142.0	159.6	159.6	159.6	159.6
Market for Chemical Plant [3]	60.0	110.0	140.0	140.0	180.0	180.0	180.0	180.0	180.0
HII Market Share	7%	23%	18%	43%	44%	44%	44%	44%	44%
Sales-Chemical Plant [4]	4.0	25.0	25.0	60.0	80.0	80.0	80.0	80.0	80.0
Total Key Product Sales	37.8	127.0	183.0	231.0	288.0	315.5	316.5	316.5	316.5
Ancillary Equipment Sales [5]	-	12.7	22.9	28.9	43.2	47.5	47.5	47.5	47.5
Jobbing Sales [6]	-	6.3	13.7	17.3	28.8	32.0	32.0	32.0	32.0
Total Sales	37.8	146.0	219.6	277.2	360.0	396.0	396.0	396.0	396.0
In-House Manufacture [7]	49%	55%	62%	69%	76%	81%	81%	81%	81%
Value Added	18.5	80.3	136.2	191.3	273.6	320.8	320.8	320.8	320.8
B. Sales in Current US Dollars (Millions) [8]									
Total Sales	44.1	184.0	296.0	400.0	555.8	654.2	700.0	749.0	801.4
C. Sales in Current Won (Billions) [9]	21.4	89.2	143.6	194.0	269.5	317.3	339.5	363.3	388.7

1/ 1978 operations are for 6 months only.

2/ 1983 sales represent the project's normal output capability at the steady state as detailed in Table 1 of this Annex. Sales are assumed to remain constant beyond 1983.

3/ Market available to the Project, by sector, is detailed in Annex 3-2.

4/ Sales forecasts are based on consideration of two factors: (a) maintenance of a reasonable build-up, in line with the project's likely manufacturing capability, through to the steady state in 1983, and (b) sales arrived at in (a) should be attainable in terms of market share.

5/ Ancillary equipment sales are forecast at the following percentages of key product sales: 0% (1978), 10% (1979), 12.5% (1980-81), 15% (1982 and beyond).

6/ Jobbing sales are forecast at the following percentages of key product sales: 0% (1978), 5% (1979), 7.5% (1980-81), 10% (1982 and beyond).

7/ In-House manufacturing percentage is: 100% less the ratio of cost of bought-out parts to sales.

8/ Inflation rates used: 8% (1977-79), 7% (1980 and beyond).

9/ US$1 = Won 485.

Industrial Projects Department
April 1977

KOREA

HEAVY MACHINERY PROJECT

HII: PROJECTED OPERATING COSTS

A. Material Costs

1. Material costs are based on analysis of raw material and bought-out parts requirements for 1983 steady state production as obtained by HII from its licensors. Information on quantities (tonnages) required is given in Annex 4-5. Quantities have been priced by HII using mid-1976 prices obtained from local and foreign suppliers/licensors (the latter being the chief source of bought-out parts). On this basis, material costs in the 1983 steady state, in constant 1976 prices, are as follows:

Steady State Material Costs
(Constant 1976 US$ millions)

	Raw Materials	Local Bought-out Parts	Foreign Bought-out Parts	Total
Steel Plant Equipment	29.8	9.1	6.5	45.4
Power Plant Equipment	52.1	11.5	25.0	88.6
Chemical Plant Equipment	26.1	8.1	8.9	43.1
Key Products Material Costs	108.0	28.7	40.4	177.1
Ancillary Equipment	20.9	-	2.3	23.2
Jobbing Work	10.1	2.5	-	12.6
Total Material Costs	139.0	31.2	42.7	212.9
Percentage Allocation	65%	15%	20%	100%

2. Total material costs amount to 53.8% of sales at the steady state (US$396 million). Based on information gathered by the Bank, this percentage is comparable with that achieved by similar heavy equipment manufacturers in the U.S., Western Europe and Japan.

3. Material costs in the years prior to the steady state, 1978-82, were arrived at for each product line in the following manner:

(a) Raw materials and bought-out parts requirements, 1978-82, were costed in the same manner as done for requirements at the steady state (para. 1). In the early years of project operations, bought-out parts will be a much higher percentage of total material costs than at the steady state. Accordingly, material costs as a percentage of sales will be significantly greater in the early years, reflecting the higher cost of bought-out parts.

(b) Inefficiency factors were applied to raw materials costs in the years prior to the steady state in order to reflect higher unit costs as a result of smaller volume purchasing and larger process losses which can be expected in these years. The factors applied to base raw material costs are:

1978 - 150%, 1979 - 140%, 1980 - 120%, 1981 - 120%, 1982 - 110%.

4. Inflation of material costs is projected at the same rate as that for sales. This is believed reasonable in light of the fact a high percentage of materials will be imported (thereby following international inflation rates) and that HII, as the sole Korean manufacturer of steel, power and chemical plant equipment, should be able to recover any material cost increases above those projected through higher prices for its final product.

5. Based on the above, material costs as a percentage of sales for 1978-83, are projected as follows:

	1978	1979	1980	1981	1982	1983
Material Costs as % of Sales	77.8%	74.9%	70.2%	64.8%	59.3%	53.8%

B. Labor Costs

6. The project will require a total of 7,780 men at steady state operations in 1983. Of these, 6,790 will be involved in manufacturing operations, the remaining 990 representing general and administrative staff. Detailed manpower projections are given in Annex 4-7. Labor costs are based on actual 1976 wage and salary levels which include fringe benefits and annual bonuses of between 2 and 3 month's salary:

Average Annual Salaries and Wages
(Constant 1976 Won)

Laborers	950,000
Shop Engineers	3,400,000
Works Management	3,400,000
Expatriates	19,200,000

7. Annual wages of Korean employees have been increased by a factor of 20% annually, 1977-1978. This is in line with wage inflation in the Korean manufacturing sector 1971-75 (as per Economic Statistics Yearbook, Bank of Korea, 1976). For 1980 and beyond, wages are assumed to inflate by 15% annually. These rates are felt to be reasonable and reflect the expected real gains in Korean wage rates as development proceeds. Inflation of expatriate salaries is forecast at 8% annually, in line with international inflation rates.

8. Labor costs projected for 1978 and 1979 take into account the fact that, in these years, HII will manufacture some equipment for the project in-house, using the knock-down kit approach. A total of Won 0.5 billion in 1978, and Won 1.1 billion in 1979 has been transferred from labor costs to fixed assets in these years to reflect the proper allocation of labor costs to the cost of equipment manufactured in-house.

C. Direct Overheads

9. Direct overheads including: operating supplies, maintenance, utilities, and freight are forecast at 7% of sales. This is in line with HII's experience on existing operations. As with labor costs, direct overheads have been reduced by Won 0.6 billion and Won 1.2 billion in 1978 and 1979, and charged to the cost of equipment manufactured in-house.

D. Royalties and Taxes

10. Royalties and taxes are forecast at 4% of sales. The royalties signed for project operations average about 3% of gross revenues, less components purchased from the licensor. A flat 2.5% has thus been assumed as the net royalty fee. By law, a business tax is charged at the rate of 1.5% on all revenues.

E. Selling and Administrative Expenses

11. Selling and administrative expenses for the project are forecast at 7% of sales. This is somewhat lower than the 9% presently experienced in HII's existing operations and reflects the fact that the project will, to some extent, share common management, services and facilities with existing operations, thereby realizing certain economies of scale.

F. Depreciation and Amortization

12. HII depreciates fixed assets on a declining balace basis, at the same rates allowed for tax purposes. These are: buildings, 5.6% annually, and machinery and equipment, 18.9% annually. No depreciation is taken on fixed asset additions during the year. The annual depreciation charge is thus based on net fixed assets at the end of the previous year. It is assumed that no revaluations of fixed assets, which are periodically allowed under Korean tax law, will occur over the forecast period. This assumption is conservative in that, although it understates depreciation, taxes are correspondingly overstated thereby understating cash flow and the after-tax financial rate of return on the Project.

13. Deferred charges, representing pre-operating expenses, are amortized on the same basis as allowed for tax purposes -- 33% each year on a declining balance basis.

G. Interest Expense

14. Interest is capitalized during the project construction period 1977-79. For 1980 and following years, interest expense is based on the following assumptions on loan amounts and terms (note that interest on the Bank loan includes a 2% guarantee fee to the Government):

	Amount (US$ millions)	Interest Rate	Repayment
World Bank	80.0	10.2	14 years including 4 years' grace
Bilateral Credits	46.7	8.0	12 years including 3 years' grace
Foreign Commercial Banks	11.9	11.0	7 years including 3 years' grace
Government Loan	79.4	13.0	8 years including 3 years' grace

H. Income Taxes

15. An income tax of 40% and a defense tax of 10% are calculated on pre-tax earnings, resulting in an effective tax rate of 50%. Losses on the project, 1978-81, are offset against earnings from HII's other operations. Also, HII is entitled to an investment tax credit of 8% of the cost of fixed assets for the Project. This tax credit (Won 9.6 billion) is applied against income taxes on HII's other operations. It may not, however, be used to offset defense taxes.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

INCOME STATEMENTS (WITH PROJECT)

(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
SALES											
MANUFACTURING	19.50	58.30	115.40	223.80	287.60	348.10	434.30	493.70	528.20	565.20	604.80
MARINE	3.60	3.90	4.20	4.50	4.90	5.20	5.60	5.90	6.40	6.80	7.30
SUB-TOTAL	23.10	62.20	119.60	228.30	292.50	353.30	439.90	499.60	534.60	572.00	612.10
COST OF SALES											
LABOR	3.00	5.48	10.95	21.25	29.62	36.87	45.60	52.30	59.84	68.75	79.23
MATERIALS	10.00	31.77	64.85	132.09	170.65	200.26	239.74	256.26	274.17	293.38	313.93
DIRECT OVERHEAD	1.50	4.66	8.42	15.81	21.57	25.91	32.05	36.32	38.86	41.58	44.50
ROYALTIES AND TAXES	.50	1.75	3.68	7.61	10.06	12.38	15.72	17.98	19.24	20.59	22.03
TOTAL MFG COST OF SALES	15.00	43.67	87.89	176.76	231.90	275.42	333.12	362.87	392.11	424.30	459.69
MARINE COST OF SALES	2.10	2.34	2.52	2.70	2.94	3.12	3.36	3.54	3.84	4.08	4.38
TOTAL COST OF SALES	17.10	46.01	90.41	179.46	234.84	278.54	336.48	366.41	395.95	428.38	464.07
GROSS PROFIT											
GROSS PROFIT	6.00	16.19	29.19	48.84	57.66	74.76	103.42	133.19	138.65	143.62	148.03
INDIRECT EXPENSES											
SELLING AND ADMIN.	2.00	5.60	10.34	18.76	23.45	27.92	34.20	38.62	41.32	44.21	47.31
DEPRECIATION AND AMORT.	2.20	3.40	9.80	18.90	21.20	17.30	14.30	11.90	10.00	8.10	6.80
INTEREST EXPENSES 1/	2.00	2.90	2.60	2.20	11.65	10.56	9.12	7.50	5.82	4.38	3.26
INCOME FROM OTHER SOURCES	(.90)	(.62)	(.98)	(1.39)	(1.49)	(1.59)	(1.70)	(1.82)	(1.95)	(2.09)	(2.23)
TOTAL INDIRECT EXPENSES	5.30	11.28	21.75	38.47	54.81	54.19	55.91	56.20	55.19	54.61	55.14
PROFIT											
PROFIT BEFORE TAXES	.70	4.92	7.44	10.37	2.85	20.57	47.51	77.00	83.46	89.01	92.89
INCOME TAXES 2/ 3/	.10	1.18	3.51	4.76	.97	9.80	23.24	37.95	41.16	43.92	45.84
INVESTMENT TAX CREDIT	-	.95	2.81	3.81	.78	1.26	-	-	-	-	-
NET PROFIT 1/	.60	4.68	6.73	9.41	2.65	12.03	24.27	39.04	42.30	45.09	47.05
RATIO ANALYSIS											
GROSS PROFIT AS % SALES	25.97	26.03	24.41	21.39	19.71	21.16	23.51	26.66	25.94	25.11	24.18
PRE-TAX PROFIT AS % SALES	3.03	7.91	6.22	4.54	.97	5.82	10.80	15.41	15.61	15.56	15.18
DEBT SERVICE COVERAGE	1.26	1.37	1.77	2.05	1.63	1.53	1.82	2.35	2.79	3.59	4.39
PRE-TAX RETURN ON -											
AVERAGE TOTAL ASSETS	8.17	10.69	6.57	5.18	4.91	9.60	15.92	21.48	20.44	19.33	17.94
AVERAGE EQUITY	10.61	34.70	24.15	21.07	4.77	30.70	55.78	65.90	52.99	44.24	37.57

1/ Interest during construction on the project is capitalized 1977-79. This accounts for the jump in interest expense in 1980 and the corresponding reduction in earnings in that year.

2/ Income taxes, but not defense taxes, are eliminated 1976-1980, and reduced in 1981, due to the investment tax credits totalling Won 11.1 billion on the Gunpo expansion and the proposed project. The overall tax rate 1981-86 is slightly below the normal rate of 50% due to the exemption from taxes allowed on HII's marine operations.

3/ If HII were to go public, as planned, after 1983, the income tax rate would drop from the private company rate of 50% to the public company rate of 31%.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

INCOME STATEMENT (PROJECT)

(Won Billions)

	1976	1977	1978 1/	1979	1980	1981	1982	1983	1984	1985	1986
SALES 2/											
MANUFACTURING	-	-	21.40	89.20	143.60	194.00	269.50	317.30	339.50	363.30	388.70
MARINE	-	-	-	-	-	-	-	-	-	-	-
SUB-TOTAL	-	-	21.40	89.20	143.60	194.00	269.50	317.30	339.50	363.30	388.70
COST OF SALES 2/											
LABOR	-	-	2.20	9.81	16.51	21.92	28.30	32.36	37.01	42.51	48.98
MATERIALS	-	-	16.63	66.81	100.81	125.52	159.81	170.71	182.65	195.46	209.12
DIRECT OVERHEAD	-	-	.90	5.04	10.05	13.58	18.87	22.21	23.76	25.43	27.21
ROYALTIES AND TAXES	-	-	.86	3.57	5.74	7.76	10.78	12.69	13.58	14.53	15.55
TOT MFG COST OF SALES	-	-	20.59	85.23	133.12	168.78	217.76	237.98	257.00	277.92	300.85
MARINE COST OF SALES	-	-	-	-	-	-	-	-	-	-	-
TOTAL COST OF SALES	-	-	20.59	85.23	133.12	168.78	217.76	237.98	257.00	277.92	300.85
GROSS PROFIT											
GROSS PROFIT	-	-	.81	3.97	10.48	25.22	51.74	79.32	82.50	85.38	87.85
INDIRECT EXPENSES 3/											
SELLING AND ADMIN.	-	-	1.50	6.24	10.05	13.58	18.87	22.21	23.76	25.43	27.21
DEPR. AND AMORTIZATION	-	-	5.80	15.20	17.90	14.40	11.70	9.60	7.90	6.30	5.20
INTEREST EXPENSES 4/	-	-	-	-	9.75	9.36	8.12	6.70	5.22	3.88	2.86
INCOME FROM OTHER SOURCES	-	-	-	-	-	-	-	-	-	-	-
TOTAL INDIRECT EXPENSES	-	-	7.30	21.44	37.70	37.34	38.68	38.51	36.89	35.61	35.27
PROFIT											
PROFIT BEFORE TAXES	-	-	(6.48)	(17.48)	(27.22)	(12.12)	13.06	40.81	45.61	49.76	52.58
INCOME TAXES 5/	-	-	(3.24)	(8.74)	(13.61)	(6.06)	6.53	20.41	22.81	24.88	26.29
INVESTMENT TAX CREDIT 6/	-	.95	2.81	3.81	.78	1.26	-	-	-	-	-
NET PROFIT	-	.95	(.43)	(4.93)	(12.83)	(4.81)	6.53	20.41	22.81	24.88	26.29

1/ 1978 operations are for 6 months only.

2/ Details on projected sales are given in Annex 7-2.

3/ Details on cost of sales and indirect expenses are given in Annex 7-3.

4/ Interest during construction, 1977-79, is capitalized. Accordingly, no interest expense appears on the project income statement until 1980.

5/ Income taxes, including defense taxes, are calculated at 50% of pre-tax earnings. Losses on the project, 1978-81, are offset against earnings from HII's other operations, resulting in tax savings as indicated. If HII were to go public, as planned, after 1983, its income tax rate would would drop to the 3½% preferential rate for public companies.

6/ HII is entitled to an investment tax credit of 8% of the cost of fixed assets for the project. This tax credit (Won 9.6 billion) is used to reduce income taxes, but not defense taxes which must always be paid, on HII's other operations in the years 1977-81 as indicated above.

Industrial Projects Department
May 1977

KOREA

HEAVY MACHINERY PROJECT

SOURCES AND APPLICATIONS OF FUNDS (WITH PROJECT)

(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
SOURCES											
FROM OPERATIONS											
NET PROFIT AFTER TAX	.60	4.68	6.73	9.41	2.65	12.03	24.22	39.04	42.30	45.09	47.05
DEPR. AND AMORT.	2.20	3.50	9.70	19.00	21.10	17.40	14.20	12.00	9.90	8.30	6.80
INC. IN RETR. RESERV.	.60	.30	.70	1.30	1.20	1.10	1.10	.80	.80	1.10	1.10
TOTAL FROM OPERATIONS	3.40	8.48	17.13	29.71	24.95	30.53	39.57	51.84	53.00	54.49	54.95
INCREASE IN LTD											
DEBT RAISED FOR PROJECT											
WORLD BANK	-	6.20	28.40	4.20	-	-	-	-	-	-	-
BILATERAL CREDITS	-	5.70	7.50	9.50	-	-	-	-	-	-	-
FOREIGN COMMERCIAL BNKS	-	1.60	1.90	2.30	-	-	-	-	-	-	-
GOVERNMENT LOAN	-	16.77	9.47	9.09	3.20	-	-	-	-	-	-
SUB-TOTAL	-	30.27	47.27	25.09	3.20	-	-	-	-	-	-
OTHER DEBT	16.80	4.70	-	-	-	-	-	-	-	-	-
TOTAL INCR. IN LTD	16.80	34.97	47.27	25.09	3.20	-	-	-	-	-	-
INCREASE IN EQUITY											
ISSUE OF SHARES/ SUBORDINATED LOANS	-	10.06	11.77	8.90	-	-	-	-	-	-	-
TOTAL SOURCES	20.20	53.51	76.17	63.70	28.15	30.53	39.57	51.84	53.00	54.49	54.95
APPLICATIONS											
FIXED ASSETS (INCL. IDC)											
PROJECT FIXED ASSETS	1.40	35.40	57.10	37.90	-	-	-	-	-	-	-
OTHER FIXED ASSETS	12.80	5.80	1.20	1.10	1.00	.90	1.00	.90	.80	.90	.80
TOTAL FIXED ASSETS	14.20	41.20	58.30	39.00	1.00	.90	1.00	.90	.80	.90	.80
DEFERRED EXPENDITURES											
PROJECT RELATED	.50	3.50	2.60	.50	-	-	-	-	-	-	-
OTHER	(.90)	.30	.50	.60	.50	.40	.30	.20	.20	.10	.20
TOTAL DEFERRED EXP	(.40)	3.80	3.10	1.10	.50	.40	.30	.20	.20	.10	.20
REPAYMENTS OF LONG-TERM DEBT											
DEBT RAISED FOR THE PROJECT											
WORLD BANK	-	-	-	-	-	3.90	3.90	3.90	3.90	3.90	3.90
BILATERAL CREDITS	-	-	-	-	2.50	2.50	2.50	2.50	2.50	2.50	2.50
FOREIGN COMMERCIAL BNKS	-	-	-	-	1.40	1.50	1.40	1.50	-	-	-
GOVERNMENT LOANS	-	-	-	-	3.35	5.25	7.07	7.71	7.71	4.35	2.46
SUB-TOTAL	-	-	-	-	7.25	13.15	14.87	15.61	14.11	10.75	8.86
OTHER DEBT	1.80	3.70	3.00	4.10	2.90	2.30	2.20	1.80	.90	.90	.90
TOTAL REPAYMENT OF LTD	1.80	3.70	3.00	4.10	10.15	15.45	17.07	17.41	15.01	11.65	9.76
INC. IN WORKING CAPITAL (EXCLUDING CURRENT PORT OF LTD)											
PROJECT WORKING CAPITAL	-	.02	6.76	14.85	12.56	3.78	15.87	12.09	4.61	4.95	4.65
OTHER WORKING CAPITAL	4.60	4.79	5.01	4.65	3.94	1.49	1.52	1.63	1.72	1.79	1.87
TOTAL INC. IN WORKING CAP.	4.60	4.81	11.77	19.50	16.50	5.27	17.39	13.72	6.32	6.74	6.53
TOTAL APPLICATIONS	20.20	53.51	76.17	63.70	28.15	22.01	35.75	32.23	22.33	19.39	17.28
INC. IN SURP. CASH	-	-	-	-	-	8.52	3.82	19.61	30.67	35.10	37.67

INDUSTRIAL PROJECTS DEPARTMENT
May 1977

KOREA

HEAVY MACHINERY PROJECT

BALANCE SHEET (WITH PROJECT)

(Won Billions)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ASSETS											
CURRENT ASSETS 1/											
CASH	5.80	1.24	2.39	4.57	5.85	7.07	8.80	9.99	10.69	11.44	12.24
ACCOUNTS RECEIVABLES	3.70	9.33	18.39	38.10	51.61	64.71	83.78	96.44	103.19	110.42	118.15
ADVANCES TO SUPPLIERS	-	3.75	9.95	13.05	14.02	15.03	14.35	15.35	16.43	17.58	18.74
INVENTORIES											
RAW MAT. AND SUPPL.	2.40	6.99	16.30	24.26	31.82	33.32	39.88	42.62	45.60	48.80	52.22
GOODS IN PROC/FIN.GDS	3.00	10.49	34.04	57.22	80.48	102.26	116.11	133.88	143.25	153.28	164.01
TOTAL INVENTORIES	5.40	17.48	50.34	81.48	112.30	135.57	155.99	176.51	188.85	202.08	216.23
PRE-PAID EXPENSES/OTHER	4.20	3.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
TOTAL CURRENT ASSETS	19.10	34.81	85.07	142.19	188.79	227.37	267.91	303.30	324.16	346.52	370.37
SURPLUS CASH	-	-	-	-	-	8.52	12.34	31.95	62.62	97.72	135.39
FIXED ASSETS											
GROSS FIXED ASSETS	28.50	69.70	128.00	167.00	168.00	168.90	169.90	170.80	171.60	172.50	173.30
ACCUM. DEPRECIATION	3.60	6.90	14.20	31.10	50.80	67.00	80.40	91.70	101.10	109.00	115.50
NET FIXED ASSETS	24.90	62.80	113.80	135.90	117.20	101.90	89.50	79.10	70.50	63.50	57.80
INVESTMENTS AND LT REC.	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30	.30
DEFERRED CHARGES											
GROSS DEFERRED CHARGES	.40	4.20	7.30	8.40	8.90	9.30	9.60	9.80	10.00	10.10	10.30
ACCUM. AMORTIZATION	.20	.40	2.80	4.90	6.30	7.50	8.30	9.00	9.50	9.90	10.20
NET DEFERRED CHARGES	.20	3.80	4.50	3.50	2.60	1.80	1.30	.80	.50	.20	.10
TOTAL ASSETS	44.50	101.71	203.67	281.89	308.89	339.89	371.35	415.45	458.08	508.24	563.96
LIABILITIES AND EQUITY											
CURRENT LIABILITIES 1/											
ACCOUNTS PAYABLE	5.90	10.32	22.11	35.86	45.02	53.55	61.03	66.46	71.36	76.64	82.36
ADVANCES FROM CUSTOMERS	-	9.14	34.84	57.71	81.19	105.98	121.65	137.88	147.53	157.86	169.47
SHORT-TERM BANK LOANS	7.20	2.54	2.54	2.54	-	-	-	-	-	-	-
ACCRUED EXPENSES	2.00	4.00	5.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
CURRENT PORT OF LT DEBT	3.70	3.00	4.10	10.15	15.45	17.07	17.41	15.01	11.65	9.76	7.20
TOTAL CURRENT LIABILITIES	18.80	29.00	68.59	112.27	147.66	182.59	206.09	225.35	236.54	250.26	265.03
RETIREMENT RESERVE 2/	.60	.90	1.60	2.90	4.10	5.20	6.30	7.10	7.90	9.00	10.10
LONG-TERM DEBT											
TOTAL LTD (EXCL. GOVT. LNS)	22.00	36.50	71.30	83.20	76.40	66.20	56.20	46.50	39.20	31.90	24.60
GOVERNMENT LOAN	-	16.77	26.24	35.33	35.17	29.93	22.86	15.16	7.45	3.10	.64
LESS CURRENT PORTION	3.70	3.00	4.10	10.15	15.45	17.07	17.41	15.01	11.65	9.76	7.20
NET LONG-TERM DEBT	18.30	50.27	93.44	108.37	96.13	79.06	61.66	46.65	35.00	25.24	18.04
EQUITY											
CAPITAL STOCK	6.00	16.06	27.83	36.73	36.73	36.73	36.73	36.73	36.73	36.73	36.73
REVALUATION SURPLUS	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
RETAINED EARNINGS	.60	5.28	12.01	21.43	24.08	36.11	60.38	99.42	141.72	186.81	233.86
TOTAL EQUITY	6.80	21.54	40.04	58.35	61.01	73.04	97.31	136.35	178.65	223.74	270.79
TOTAL LIABILITIES AND EQUITY	44.50	101.71	203.67	281.89	308.89	339.89	371.35	415.45	458.08	508.24	563.96
R A T I O S											
DEBT/EQUITY RATIO	.73	.70	.70	.65	.61	.52	.39	.25	.16	.10	.06
CURRENT RATIO	1.02	1.20	1.24	1.27	1.28	1.25	1.30	1.35	1.37	1.38	1.40
CURRENT RATIO (WITH SURP. CASH)	1.02	1.20	1.24	1.27	1.28	1.29	1.36	1.49	1.64	1.78	1.91

1/ Current assets and current liabilities are the summation of requirements arrived at for working capital needs (without the project), Annex 2-9, page 5, and working capital needs (project alone), Annex 5-2.

2/ Under Korean tax law, companies must set up a reserve for severance pay due on retirement of employees. The maximum allowed amount of this reserve is 10% of annual salaries.

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KOREA

HEAVY MACHINERY PROJECT

BREAK-EVEN ANALYSIS

The Project is expected to be completed by the end of 1979 and expected to reach the steady state of operations in 1983. Therefore, the year 1983 has been selected as the basis for the break-even point analysis.

Cost Items	Cost (Won billion)		
	Variable Cost	Fixed Cost	Total Cost
Materials & Components	162.2	8.5	170.7
Labor	3.2	29.2	32.4
Direct overhead	11.1	11.1	22.2
Royalties and Taxes	12.7	-	12.7
Selling and Administration	2.2	20.0	22.2
Depreciation and Amortization	-	9.6	9.6
Financial charges	-	6.7	6.7
TOTAL	191.4	85.1	276.5

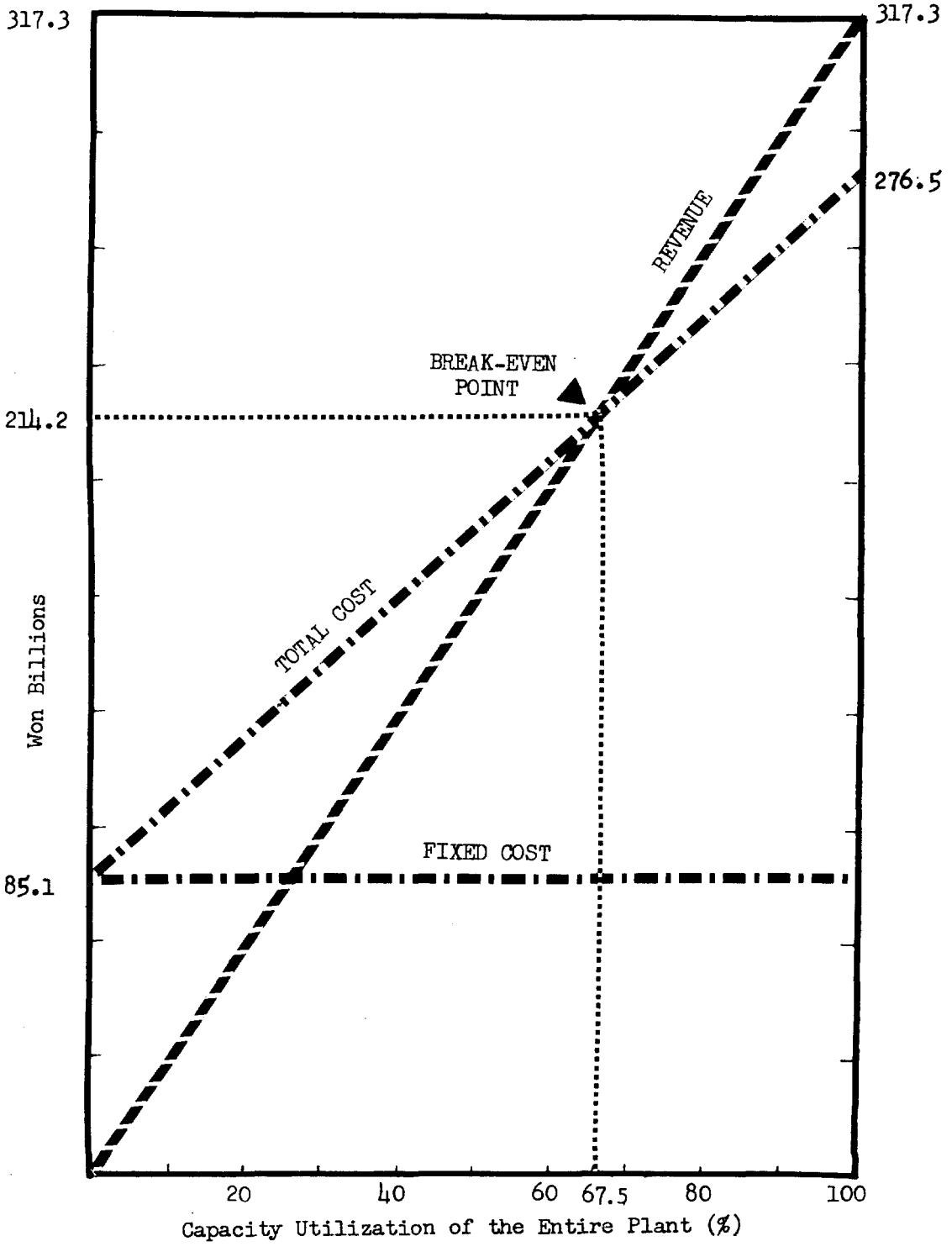
Revenue	317.3 billion Won
Profit Break-Even	67.5% of Total Plant Capacity
Debt Repayment	15.6 billion Won
Cash Break-Even	72.5% of Total Plant Capacity

KOREA

HEAVY MACHINERY PROJECT

BREAK-EVEN CHART

The profit break-even point of the Project at steady state of operation in 1983 is estimated to be around 67.5%.



Industrial Projects Department
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KOREA

HEAVY MACHINERY PROJECT

FINANCIAL RATE OF RETURN AND SENSITIVITY ANALYSIS

Assumptions

1. The financial rate of return calculations are based on the incremental capital cost, operating cost, and revenue streams shown on page 2 of this annex. All streams have been deflated to 1976 price terms on the basis of international inflation rates: 8%, 1977-79, and 7% thereafter.

2. Other basic assumptions used in the financial rate of return calculation are as follows:

Construction Period:	4 years
Life of Project:	18 years from the date of mechanical completion (1979)

Industrial Projects Department
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KOREA

HEAVY MACHINERY PROJECT

FINANCIAL RATE OF RETURN AND SENSITIVITY ANALYSIS

Cost and Benefit Streams

(Constant 1976 Won Billions)

Year	Fixed Assets	Working Capital	Total Capital Costs	Operating Costs	Revenues
1976	0.5	-	0.5	-	-
1977	30.4	-	30.4	-	-
1978	46.1	5.8	51.9	19.0	18.4
1979	29.6	11.4	41.0	72.6	70.8
1980	-0.9 1/	8.2	7.3	106.2	106.5
1981	-	1.0	1.0	126.5	134.4
1982	-	8.6	8.6	153.3	176.5
1983	-	5.0	5.0	157.5	192.1
1984-99	-	-	-	157.5	192.1
2000	-	(39.9) 2/	(39.9) 2/	-	-

1/ Investment Credit against Capital Expenditures.

2/ Recovery of working capital.

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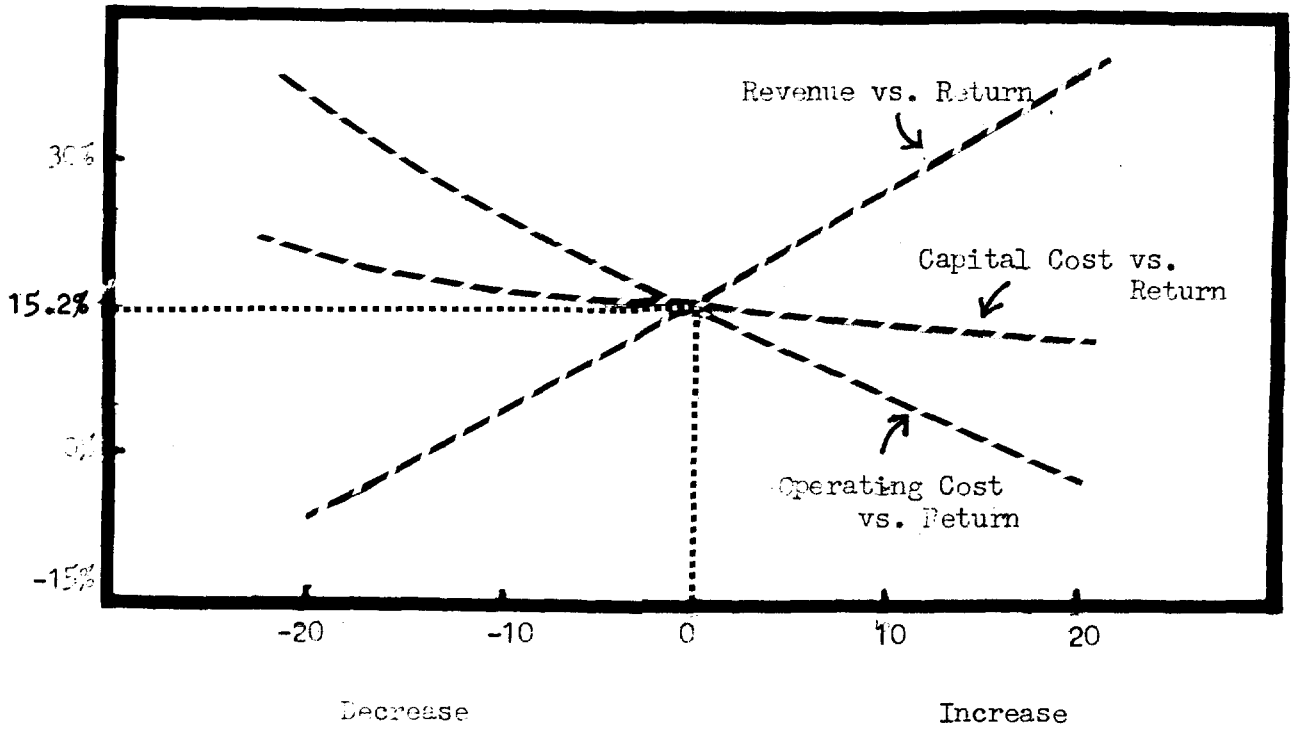
ROSE

HEAVY MACHINERY PROJECT

FINANCIAL RATE OF RETURN AND SENSITIVITY ANALYSIS

Sensitivity Analysis



Case	Capital Costs	Operating Costs	Revenues	Pre-Tax Return
1 (Base Case)	100	100	100	15.2
2	110	100	100	14.3
3	120	100	100	13.4
4	100	110	100	6.7
5	100	120	100	(4.8)
6	100	100	90	4.9
7	100	100	80	(12.9)
8	100	90	90	13.9
9	100	80	80	12.6
10	100	110	110	16.4
11	100	120	120	17.5
12	110	110	100	6.1
13	120	120	100	(5.3)
14	100	90	100	23.0
One Year Project Delay				13.9

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KOREA

HEAVY MACHINERY PROJECT

ECONOMIC RATE OF RETURN AND SENSITIVITY ANALYSIS

Assumptions

The economic rate of return for the Project has been calculated on the basis of cost and benefit streams expressed in 1976 constant terms. These streams are based on those used for the financial rate of return calculation (Annex 7-8) adjusted to reflect costs and benefits to the economy as a whole. No shadow pricing of labor or foreign exchange has been used. Adjustments to the financial rate of return calculations are as follows:

(a) Capital Costs: Business taxes at 1.5% of the value of local materials have been excluded from local components of capital costs and working capital needs. The Project is 90% exempt from import duties (which would normally average 20%) on fixed assets; a defense tax of 2.5%, however, must still be paid. Total duties and taxes of 4.5% have thus been excluded from foreign fixed assets for the Project. Imported materials for working capital needs will also be largely exempt from duties since such materials will be incorporated into products to be sold to entities such as KECO and POSCO which, like HII, are 90% exempt from duties on their expansion programs. Thus, duties and taxes assumed to average 5%, have been excluded from foreign working capital needs.

(b) Operating Costs: Duties and defense taxes, averaging 5%, have been excluded from foreign material costs. Business taxes of 1.5% have been excluded from local material co ts.

(c) Revenues: No changes have been made to benefit stream which are already valued at international prices.

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HEAVY MACHINERY PROJECT

ECONOMIC RATE OF RETURN AND SENSITIVITY ANALYSIS

Cost and Benefit Streams
(Constant 1976 Won Billions)

Year	Fixed Assets	Working Capital	Total Capital Costs	Operating Costs	Revenues
1976	1.3	-	1.3	-	-
1977	31.4	-	31.4	-	-
1978	46.9	5.1	52.0	18.1	18.4
1979	29.8	10.5	40.3	69.7	70.8
1980	-	8.0	8.0	102.5	106.5
1981	-	1.0	1.0	122.2	134.4
1982	-	8.6	8.6	148.6	174.5
1983	-	5.0	5.0	153.1	192.1
1984-99	-	-	-	153.1	192.1
2000	-	38.2 1/	38.2 1/	-	-

1/ Recovery of working capital

Industrial Projects Department
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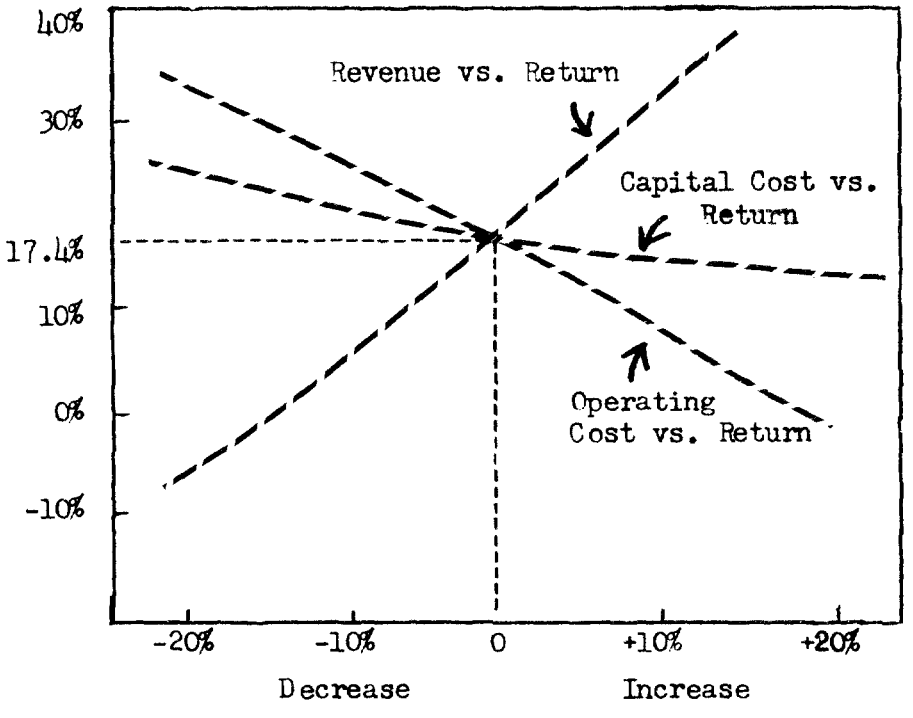
KOREA

HEAVY MACHINERY PROJECT

ECONOMIC RATE OF RETURN AND SENSITIVITY ANALYSIS

Sensitivity Analysis



Case	Capital Costs	Operating Costs	Revenues	Economic Rate of Return
1 (Base Case)	100	100	100	17.4
2	110	100	100	16.4
3	120	100	100	15.4
4	100	110	100	9.5
5	100	120	100	(0.3)
6	100	100	90	7.7
7	100	100	80	(7.0)
8	100	90	90	16.0
9	100	80	80	14.5
10	100	110	110	18.8
11	100	120	120	20.1
12	110	110	100	8.8
13	120	120	100	(1.0)
One Year Project Delay				15.8

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KOREA

HEAVY MACHINERY PROJECT

FOREIGN EXCHANGE SAVINGS

(Constant 1976 Won Billion)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
I. FOREIGN EXCHANGE INFLOW & SAVINGS											
1. Loans	-	12.5	32.4	12.7	-	-	-	-	-	-	-
2. Foreign Exchange Savings 1/	-	-	18.4	65.1	97.9	123.5	160.4	176.6	176.6	176.6	176.6
TOTAL INFLOW & SAVINGS	-	12.5	50.8	77.8	97.9	123.5	160.4	176.6	176.6	176.6	176.6
II. FOREIGN EXCHANGE OUTFLOW											
a) Capital Expenditures											
1. Fixed Assets for the Project 2/	0.4	16.7	38.3	15.9	-	-	-	-	-	-	-
2. Working Capital 3/	-	2.0	12.9	7.9	2.5	(1.6)	(6.6)	(4.0)	-	-	-
Subtotal	0.4	18.7	51.2	23.2	2.5	(1.6)	(6.6)	(4.0)	-	-	-
b) Operating Expenditures											
1. Foreign Staff	-	-	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-
2. Raw Materials and Components	-	-	8.8	28.7	32.4	29.7	23.4	15.3	15.3	15.3	15.3
3. Royalties	-	-	0.5	1.7	2.7	3.4	4.4	4.8	4.8	4.8	4.8
4. Other Overhead Expenses	-	-	0.9	2.9	3.2	3.0	2.3	1.5	1.5	1.5	1.5
Subtotal	-	-	10.6	33.6	38.6	36.4	30.4	21.9	21.6	21.6	21.6
c) Exports Forgone 4/	-	-	-	13.0	22.9	31.4	44.1	49.6	49.6	49.6	49.6
d) Debt Service											
1. Interest	-	0.6	2.8	4.8	4.7	4.0	3.2	2.5	2.0	1.5	1.1
2. Debt Repayment	-	-	-	-	2.9	5.5	5.1	4.8	3.6	3.4	3.2
Subtotal	-	0.6	2.8	4.8	7.6	9.5	8.3	7.3	5.6	4.9	4.3
TOTAL OUTFLOW	0.4	19.3	64.6	74.6	71.6	75.7	76.2	74.8	76.8	76.1	75.5
III. FOREIGN EXCHANGE SURPLUS (Deficit)	(0.2)	(6.8)	(13.8)	3.2	26.3	47.8	84.2	101.8	99.8	100.5	101.1

1/ Equal to total revenues less jobbing sales.

2/ Fixed assets include indirect foreign exchange in local costs.

3/ Working capital requirements in foreign exchange decline, 1981-83, due to reduced reliance on foreign bought-out parts.

4/ Represents cost of steel and other local materials required for Project operations, which might otherwise have been exported.

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ANNEX 8-2

KOREA

HEAVY MACHINERY PROJECT

CASH FLOW TO THE GOVERNMENT

(Won Billions)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Cash Inflows 1/										
1. Income Taxes 2/	(1.0)	(6.0)	(12.5)	(14.4)	(7.3)	6.5	20.4	22.8	24.9	26.3
2. Business Taxes	-	0.3	1.3	2.2	2.9	4.0	4.8	5.1	5.5	5.8
3. Duties on Imported Materials	-	0.5	2.0	2.5	2.4	2.0	1.4	1.5	1.6	1.7
4. Duties on Imported Fixed Assets	1.2	1.9	1.1	-	-	-	-	-	-	-
5. Guarantee Fee on Bank Loan	0.1	0.4	0.7	0.8	0.7	0.7	0.6	0.5	0.4	0.3
6. Interest on Government Loan	1.1	2.7	4.1	4.1	4.2	3.4	2.4	1.5	0.7	0.2
7. Repayment of Government Loan	-	-	-	3.4	5.3	7.1	7.7	7.7	4.4	2.5
	1.4	(0.2)	(3.3)	1.4	8.2	23.7	37.3	39.1	37.5	36.8
Cash Outflows										
1. Infrastructure Costs	0.7	1.3	-	-	-	-	-	-	-	-
2. Loan to Project	16.2	9.5	11.2	5.4	-	-	-	-	-	-
	16.9	10.8	11.2	5.4	-	-	-	-	-	-
Net Cash Flow (Current Terms)	(15.5)	(11.0)	(14.5)	(6.8)	8.2	23.7	37.3	39.1	37.5	36.8
Net Cash Flow (Constant 1976 Terms)	(14.4)	(9.4)	(11.5)	(5.0)	5.7	15.4	22.5	22.1	19.8	18.2

1/ Does not include indirect cash flows such as income taxes paid by workers on their salaries, or imputed income taxes on sales of materials and components to the Project by local suppliers.

2/ Income taxes are negative, 1977-81, due to the utilization of losses on the Project and the investment tax credit to offset income taxes which would be otherwise payable on HII's existing operations.

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ANNEX 8-3